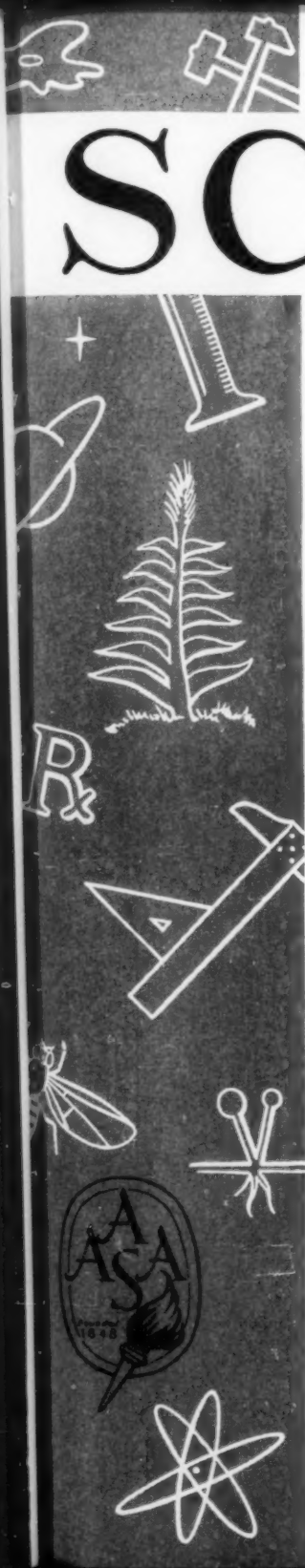

# SCIENCE

JULY 3, 1953

VOLUME 118 NUMBER 3053

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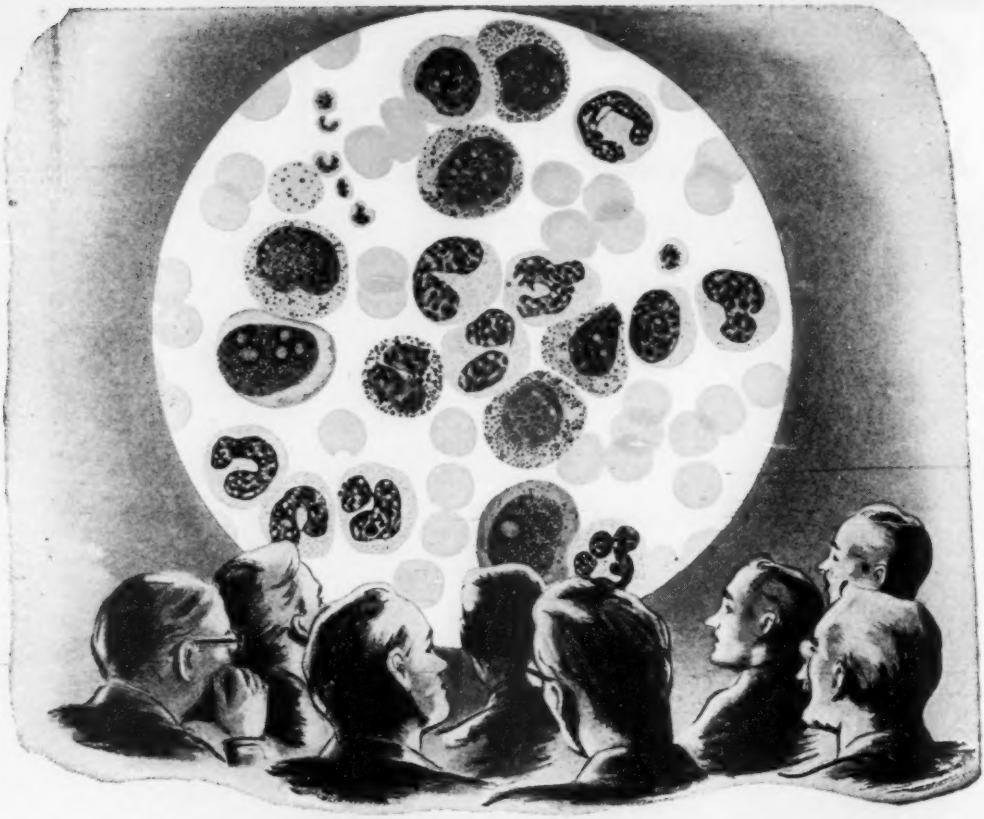

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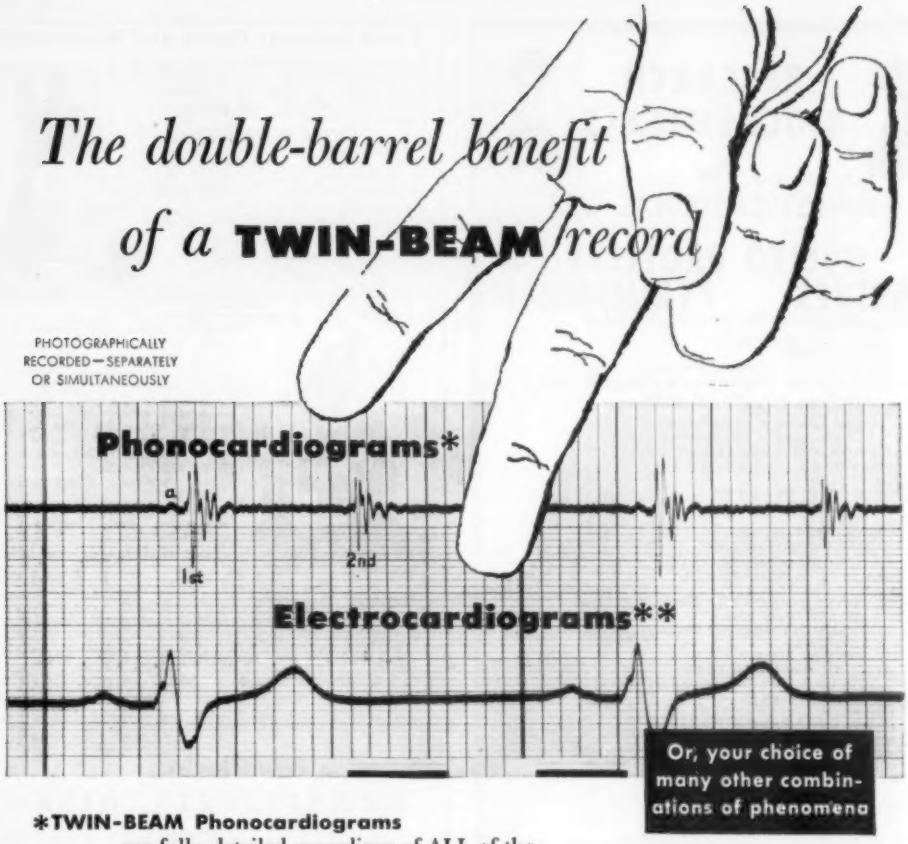


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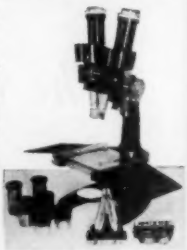

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# Oceanographic Institute of Nhatrang, Viet Nam

TOO few American scientists are aware of the existence of the *Institut Océanographique de Nhatrang* (formerly *d'Indochine*), a research establishment of major size, potentially the most productive marine station in southeast Asia [see also article by Dr. Talbot Waterman in the *American Scientist*, 41, 292 (1953)]. Although Indo-China has long been a place of remote interest to Americans, the recent political revolutions and current military activities are bringing it more and more sharply to our attention. It was the interest of the Pacific Science Board of the National Academy of Science—National Research Council in helping to sustain this institution through these unsettled and trying times that provided my opportunity for ten weeks of marine botanical work there early this year.

The Institute is magnificently situated on a promontory of Nhatrang Bay opposite a splendid harbor sheltered from the open South China Sea by several islands. The laboratories are housed in four concrete buildings, two of which have three floors. An aquarium occupies the ground floor of one building. Spacious, excellently conceived laboratories, well lighted and ventilated by constant cool breezes, provide exceptionally comfortable working conditions for a locality only twelve degrees from the equator. Housing for two or three visiting scientists is currently available in one of five large houses overlooking the Institute. Two of these are utilized by Emperor Bao Dai.

Biologists may find a great diversity of littoral marine environments within a radius of three miles of the Institute. These include mangrove swamps, mud flats, sand flats, coral reefs, coral and cobble beaches, ryolite islets, sand beaches, sea walls, and brackish estuaries. Boats of various sorts, light dredging equipment, and native divers make accessible to the investigator the organisms of the exceptionally rich infratidal region. Sea temperatures range from 24° in January to 29° in June.

Following a period of temporary abandonment during the Japanese occupation, the Institute has undergone rehabilitation, despite many difficulties, under the able and experienced direction of M. Raoul Serene. Fortunately, the library and the fine reference collections of local animals suffered relatively few losses during the occupation and have been restored and reorganized so as to provide a good basis for special studies of the multitudes of invertebrates and fishes of the region. Inasmuch as the revived Institute has not yet regained a resident staff of trained research workers, the facilities available for visiting scientists are particularly good at this time. M. Serene and his assistants are in every way cordial, helpful, and attentive in expediting the research of the visiting investigator.

To the date of writing, Nhatrang has remained a peaceful community reached in less than two hours by air from Saigon. The fine airfield is but two miles from the Institute. Manila is about four hours by air directly east.

The best opportunities at the present time are for biologists interested in special faunistic and floristic studies, although marine scientists of any specialty are welcomed. It is hoped that there may be several who will take advantage of the unusual facilities in this fascinating region.

E. YALE DAWSON
*Allan Hancock Foundation*
*University of Southern California, Los Angeles*

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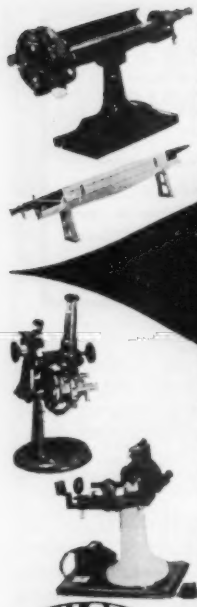

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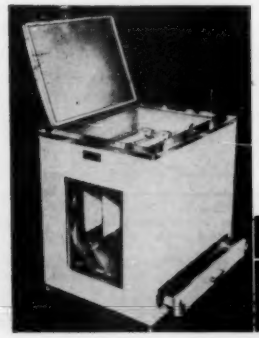

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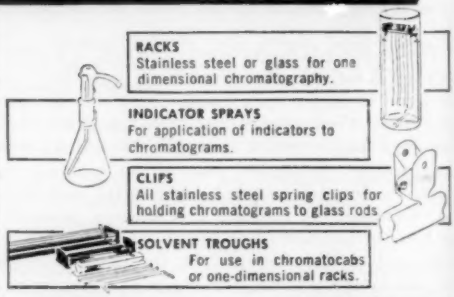

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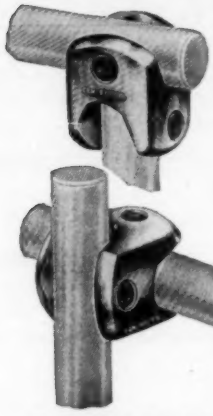

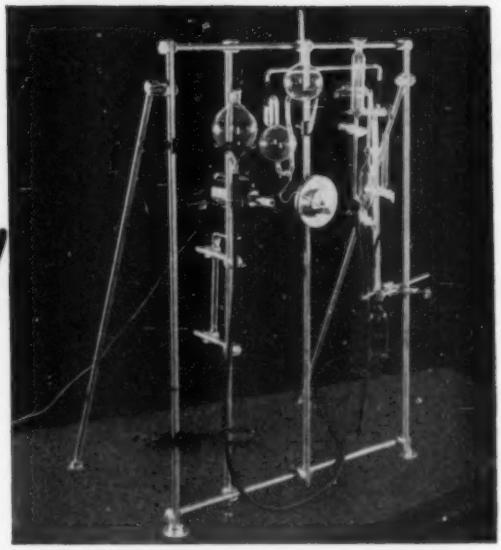

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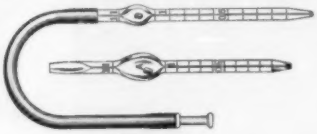

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# Yale Natural Radiocarbon Measurements, I. Pyramid Valley, New Zealand and Its Problems

Monte Blau, Edward S. Deevey, Jr., and Marsha S. Gross[1]

*Geochronometric Laboratory, Yale University, New Haven, Connecticut*

THE GEOCHRONOMETRIC LABORATORY was established in 1951 under a grant to Yale University from The Rockefeller Foundation. Its program so far has been confined to radiocarbon measurements on the lines laid down by W. F. Libby (*1–3*) and followed in other laboratories (*4–7*). It is administered by an advisory board consisting of a chemist, a physicist, a geologist, two biologists, and two archaeologists. The Laboratory considers that methodologic investigations deserve first place, and although samples of unknown age are accepted for dating, preference is given to those materials whose analysis seems likely to throw light on the reliability of $C^{14}$ dating in the widest variety of situations.

Many individuals and organizations, too numerous to mention separately, have materially assisted the program in its first two years. Particular appreciation should be expressed to Hans Suess, who conducted operations through 1951, and to the U. S. Geological Survey, which made his services available.

*Blank Determinations.* After preliminary trials beginning in October, 1951, the first "blank" measurements (of $C^{14}$ in anthracite) were made in December, 1951, and showed small but significant amounts of radioactive contamination, of the order of $0.6 \pm 0.1$ c/min. Some tests then indicated that this amount could be reduced to 0.2 c/min by rewashing the purified carbon in HCl and remounting, but it could not be eliminated. Numerous measurements in the first part of 1952 left no doubt that atomic explosions in the Pacific and in Nevada had so increased the local level of radioactive contamination that special precautions were essential if radiocarbon dating were to be possible in New Haven. Installation of a dust-free drybox (pressurized with filtered air) in which samples of purified carbon are mounted in the Libby-Kulp counter has produced satisfactory results, and no contaminated blanks were found between September, 1952, when three consecutive "zero" values were obtained on anthracite and Paleozoic limestone, and the beginning of the new series of tests in Nevada in March, 1953. A "zero" value is one in which the difference between sample and background counts is less than twice its own standard error, as shown in Table 1.

The atomic bomb tests at Eniwetok in November, 1952, contaminated two samples, as shown by remeasurements of separate portions of the same samples, but an anthracite sample prepared shortly thereafter gave a satisfactory zero, and the next sample to be counted was wood from the Two Creeks Forest Bed, Manitowoc County, Wisconsin, submitted for checking purposes by F. T. Thwaites. The calculated age of $9929 \pm 406$ years was in agreement with the average of Libby's five analyses of Two Creeks material, $11{,}400 \pm 350$ years, indicating that it was at last possible to analyze ancient materials with normal accuracy.

TABLE 1

BLANK AND CHECK DETERMINATIONS MADE SINCE SEPTEMBER, 1952

| Sample | Description | Date prepared | Date counted | Counting rate, c/min |
|---|---|---|---|---|
| Y-127h | Paleozoic limestone | August | 9/19 | $0.008 \pm 0.06$ |
| — | Anthracite | 9/22 | 9/25 | $0.081 \pm 0.06$ |
| — | Anthracite | 9/29 | 10/ 7 | $0.081 \pm 0.06$ |
| Y-127x | Paleozoic limestone | 11/12 | 11/15 | $0.028 \pm 0.07$ |
| Y-127i | Paleozoic limestone | 12/23 | 12/26 | $-0.100 \pm 0.065$ |
| Y-141 | Wood, Two Creeks Forest Bed, Manitowoc Co., Wis., coll. F. T. Thwaites | 6/12 | 11/19 | $1.697 \pm 0.086$* |

* Corrected to 100% carbon.

*Calibration Analyses of Modern Wood and Shell.* Table 2 and Fig. 1 give the results of calibration assays made since the period of possible or probable contamination. All net counts have been corrected to 100 per cent carbon, for, as was first pointed out by Libby in an unpublished memorandum, if nitric acid instead of hydrochloric acid is used to dissolve un-

[1] Supported in part by the Office of Naval Research, Project ONR-081-186, Contract Nonr 609 (05).

TABLE 2

ASSAYS OF MODERN WOOD AND SHELL

| Sample | Description | Date prepared | Counting rate, c/min | Counting rate, corrected for carbon |
|---|---|---|---|---|
| | *Wood* | | | |
| S-6 | Hemlock, cut 1951, 0–10 yr rings | 10/16/52 | 5.120 ± .093 | 6.314 ± .114* |
| 171-1 | Black oak, cut 1952, 10–20 yr rings | 12/17/52 | 5.015 ± .092 | 5.780 ± .106 |
| 171-3 | Same as 171-1 | 3/13/53 | 5.128 ± .093 | 6.080 ± .110 |
| 172-1 | Black oak, cut 1952, 10–20 yr rings | 2/10/53 | 5.078 ± .093 | 5.796 ± .106 |
| 172-2 | Same as 172-1 | 2/13/53 | 4.801 ± .088 | 5.699 ± .104 |
| | Average of modern wood, excluding S-6 | | | 5.839 ± .053 |
| | *Mollusks* | | | |
| — | Source uncertain, either *Venus* or *Donax* | 10/14/52 | 5.058 ± .076 | 6.143 ± .092 |
| — | Source uncertain, either *Venus* or *Donax* | 10/20/52 | 5.580 ± .086 | 6.618 ± .102 |
| 173 | *Venus mercenaria*, from New Haven market, prob. L. I. Sound | 1/ 5/53 | 6.002 ± .109 | 6.844 ± .124† |
| 174 | *Arca pexata*, shells on beach at Pine Orchard, Conn. (L. I. Sound) | 2/11/53 | 4.897 ± .095 | 5.824 ± .113 |
| 175 | *Ostrea virginiana*, from Rowe Oyster Co. shuck heap (L. I. Sound) | 2/23/53 | 5.045 ± .147 | 6.024 ± .175† |
| 176A | *Venus mercenaria* (shell), from Tuckernuck Shoal, Vineyard Sd., coll. alive; H. J. Turner | 3/ 3/53 | 4.987 ± .094 | 5.761 ± .109 |
| 177A | *Mytilus californianus* (shell), San Mateo Co., Calif., coll. alive; W. D. Hartman | 2/26/53 | 4.942 ± .099 | 5.738 ± .115 |
| 177B | Flesh from *Mytilus*, 177 | 3/11/53 | 5.022 ± .091 | 5.836 ± .106 |
| 200 | *Donax variabilis*, Venice, Fla.; shells in Peabody Museum, coll. 5–6 yr ago | 3/ 9/53 | 5.397 ± .092 | 6.294 ± .107 |
| 178 | *Dinocardium*, recently cast on beach (hinge ligament still present), Port Aransas, Tex.; M. D. Burkenroad | 3/ 4/53 | 4.944 ± .093 | 5.821 ± .110 |
| 205 | *Pecten* (shell), Apalachee Bay, Fla., coll. alive; Nelson Marshall | 3/16/53 | 4.464 ± .080 | 5.365 ± .096† |
| | Average of modern shell | | | |
| | All values | | | 6.043 ± .037 |
| | Excluding two high values | | | 5.871 ± .033 |

* Carbon determination on samples exposed to air for 24 hr; correction probably too high.
† Poor counts; unusual internal inconsistency.

reacted magnesium after reduction of carbon dioxide, the purified carbon is of extremely small particle size and retains about 15 per cent of water even after drying *in vacuo*. Duplicate analyses of the carbon are routinely carried out immediately after completion of a count, by means of a combustion train in which an aliquot of the dry carbon is burned in oxygen and the carbon dioxide is collected in a weighed drying tube filled with ascarite.

From Table 2 it may be seen that while modern wood gives a consistent series of $C^{14}$ values, modern marine shell provides some interesting contradictions. Of ten analyses, two are definitely higher than modern wood, agreeing with published results in suggesting a difference of the order of 10 per cent. Five of the other eight agree very closely with modern wood, and in the case of one sample (Y-177, *Mytilus californianus*), the flesh of the mollusks showed the same specific activity as the shells.

The published evidence for higher $C^{14}$ content of marine shell consists of three analyses by Libby (*8*) and five by Kulp (*4*). Several of these were duplicate runs, and it appears that only four different sources of shell were used. The higher specific activity of shell observed in the past has doubtless proved acceptable because it seemed to be in line with the known difference, of about 3 per cent, between the $C^{13}$ content of organic and inorganic carbonaceous sediments. Moreover, Craig (*9*) has found marine invertebrate carbonate to contain more $C^{13}$ than organic carbon from marine plants and animals. If, as would be expected, the effect is still greater with the heavier isotope, there would be a difference of perhaps 6 per cent or more between the $C^{14}$ content of shell and wood. This ex-

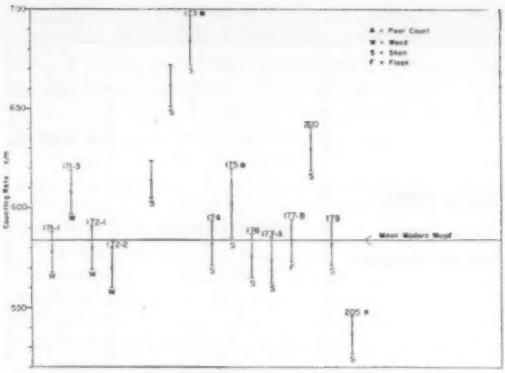


FIG. 1. Assays of modern wood and shell. The length of each line represents one standard deviation on either side of the mean.

pected difference is not borne out by our measurements.

Water from the depths of the ocean contains carbon that may be several thousand years old, and Kulp *et al.* (*5*) have suggested that coastal upwelling of deep water may account for the high apparent age (low $C^{14}$ activity) of marine shell samples from Peru, Japan, California, and the Aleutians. It seems unlikely to us that most of the marine shells we measured incorporated old carbon from upwelled water, since they came from places as different as Vineyard Sound, Long Island Sound, Venice (Florida), Port Aransas (Texas), and San Mateo County (California). It is still more unlikely that they could all have picked up just the correct amount of old carbonate to bring their counting rate to that of modern wood.

If the published $C^{13}$ and $C^{14}$ analyses are correct, how can we rationalize our determinations showing agreement between assays of shell and wood with the measurements (including two of our own) showing shell to be enriched in heavy isotopes? Although it is certainly too early to give a detailed picture, we would like to attempt a preliminary sketch. With carbon dioxide in air as a starting point, photosynthesis by plants reduces the specific activity by discriminating against the heavier isotope. Solution of $CO_2$ into sea water may be accompanied by a slight enrichment in the heavier isotopes because of the difference in solubility equilibria. Marine plants, photosynthesizing dissolved $CO_2$, discriminate against the heavier isotope just as land plants do, bringing the specific activity of their carbon down to that of wood (or perhaps to a slightly higher value because of the solubility equilibria). If marine animals deposit metabolic carbonate in their shells, the isotope ratio reflects that of their food source and will be close to that of wood. If, on the other hand, they deposit ocean carbonate directly, or if (as seems more probable) the calcium carbonate laid down at the edge of the mantle exists for some time in a form that can exchange with ocean carbonate, the shell will have a higher specific activity than wood. These various possibilities in combination will lead to variation in the $C^{14}$ content of shell, perhaps around two favored modes, one close to that of wood and the other significantly higher. We realize that this is a complex and rather special hypothesis, but it is the only one we can suggest to reconcile the available data.

Upwelling of deep ocean water containing old carbon would, of course, result in decreased specific activity of shell from the area. This situation is only likely on the west coasts of continents in subtropical latitudes, in the equatorial countercurrent region, or a few other more special localities. In fresh water lakes a far more important source of old carbon is likely to exist, wherever ground water is dissolving old limestone. It is quite probable that such water entering lakes and swamps would meet photosynthesizing plants before equilibrium with atmospheric $CO_2$ was established, giving spurious ages to photosynthetically precipitated marl or fossil plant remains, as Godwin (*10*) and others have pointed out. It may be significant in this connection that Baertschi (*11*) found less $C^{13}$ in fresh water carbonates than in marine carbonates, relative to their $O^{18}$ contents. We are presently engaged in the determination of the specific activities of various types of material from a hard-water lake. In addition, the Pyramid Valley series discussed below seems to provide a case in point.

Even in the absence of fossil carbon near the lake, there is always the possibility of the establishment of local geochemical epicycles in more or less closed habitats which produce a greater enrichment or depletion than occurs in the main cycle in the biosphere. Wickman (*12*) shows this clearly for $C^{13}$, and it may reasonably be expected to complicate $C^{14}$ contents of swamps or richly vegetated lakes.

The problem presented by modern shell analyses illustrates the fact that the biogeochemistry of carbon is too little understood to permit the uncritical application of radiocarbon dating to all carbonaceous materials regardless of their origin. While awaiting the results of studies of marine carbon in the Lamont Laboratory and of lacustrine carbon at Yale it seems best to use the standard wood value in discussing dates obtained from calcareous matter. It must always be borne in mind that such dates are far more likely to be spurious than those obtained from organic samples. We certainly feel that the practice of using a shell value 6 or 10 per cent higher than wood is in need of modification.

*Errors.* Error terms are customarily attached to radiocarbon dates on the basis of the standard deviation of the counting statistics alone. In spite of a clear discussion by Arnold (*13*), this practice has confused and misled the majority of people who are most interested in the dates. We propose to abandon it.

There are several reasons for this change. There is a widespread tendency to accept the error term, expressed in years, as being an outside limit; instead it is just the value that gives a 2 : 1 chance that the

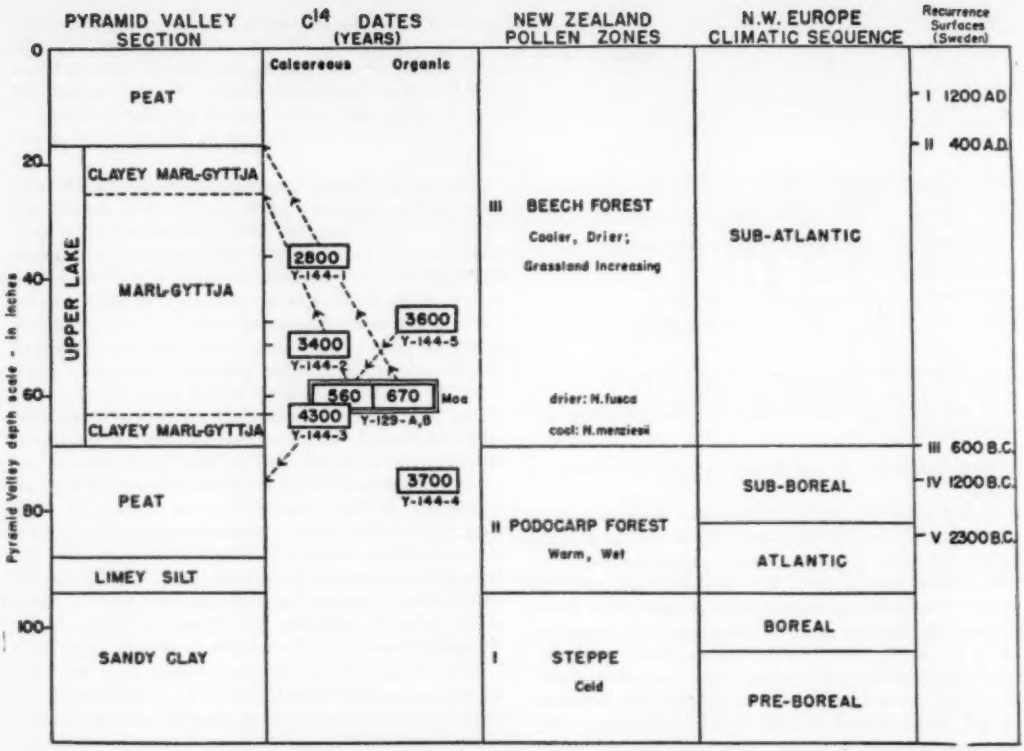


FIG. 2. Stratigraphic section through the deposits at Pyramid Valley, New Zealand, with radiocarbon dates and suggested correlations with late-Pleistocene sequences in Europe and elsewhere in New Zealand.

error is no greater than the given one. Apart from this, and contrary to the expressed opinion of other investigators, we feel that the dating process is susceptible to errors which in their cumulative effect may very well exceed those to be expected from counting statistics. Among these are the possibility of chance contamination, erratic changes in cosmic ray background, slight changes in counter efficiency, counting of spurious pulses from carbon dust or other sources, and no doubt a good many other undiagnosed difficulties in laboratory operation. Finally, there are nonlaboratory errors to be considered, and these are the ones most difficult to evaluate. These include the questions of calibration discussed above and the nature of the material to be dated, especially its mode of deposition and the circumstances of its preservation during thousands of years. These problems are being investigated, but they are amorphous and no quick solutions are in sight.

For these reasons we prefer to express our radiocarbon dates as "most probable ages" with the observation that an error of 10 per cent is not unlikely, and the warning that errors of 25 per cent are not impossible.

*Pyramid Valley, New Zealand.* A series of samples collected by R. S. Duff and R. C. Murphy from the famous moa deposit at Pyramid Valley, North Canterbury, in the South Island of New Zealand, combines methodologic and stratigraphic interest to an unusual degree. Figure 2 shows the stratigraphy of this deposit, which is discussed in great detail elsewhere (*14*). The correlation of the section with the postglacial pollen sequence in New Zealand (*15*) is based on incomplete pollen studies by W. F. Harris. The upper lake, in whose deposits the moa remains are embedded, appears to be of Sub-Atlantic age (beginning *ca.* 2500 years ago, according to the chronology widely accepted in western Europe [*16*]). The underlying sedge peat presumably dates from the Sub-Boreal, roughly 4000 to 2500 years ago. The moas were intrusive into the lake deposit, evidently having fallen through the crust provided by the uppermost forest humus while feeding on podocarp trees, and the humus itself presumably records a relatively dry phase, to be correlated with one of the climatic cycles that produced "recurrence surfaces" in European bogs. Points of greatest stratigraphic interest include (1) the use of radiocarbon dates to confirm interhemisphere correlation of late-Pleistocene climatic sequences, amplifying what can be tentatively inferred from scanty pollen data, and (2) the age of the moas. There is no good evidence that the Maori, who reached

the North Island in force about A.D. 1350, ever knew the moas, and the moa that was hunted by the basically Polynesian but non-Maori people known as Moa-hunters (*17*), whose sites are chiefly found on the South Island, was a small species, *Euryapteryx*. For the other moas, especially the largest type, *Dinornis*, mystery surrounds both the cause of extinction and its date. Pyramid Valley contains no archaeologic remains, but it is one of several places where *Euryapteryx* and *Dinornis* occur together.

The methodologic interest of the series consists in the possibility of comparison of radiocarbon analyses based on carbonates and organic carbon at the same stratigraphic horizon. Not many marine shells had been tested at the time the study was undertaken, and no difficulty was anticipated from using such comparisons to explore the carbon cycle of hard freshwater lakes. The Pyramid Valley swamp is surrounded by Tertiary limestone, and this rich source of fossil carbon might be expected to contribute old carbon to the lake by way of bicarbonate in ground water. If carbon exchange between the lake or ground water and the atmosphere is slow, a departure from equilibrium would result, and the water, the organisms, and particularly the sediments of the lake would give spuriously high radiocarbon ages. This expectation seems to be confirmed, although the uncertainty in the modern $C^{14}$ content of carbonate carbon makes the demonstration less striking than it appeared at first.

Table 3 gives the results, duplicate determinations having been made wherever possible; ages of calcareous samples are calculated according to two assumptions, that the $C^{14}$ contents of shell and wood are identical and that modern shell contains 10 per cent more $C^{14}$ than modern wood. The former assumption, of course, reduces the ages of calcareous samples, but it may be seen that on this assumption the oldest marl (sample Y-144-3) appears older, and on the latter assumption all three marl samples appear as old or older than the peat (sample Y-144-4) that underlies the marl.

The age of the moa is presumably correctly given by the age of the organic fraction of its crop contents, 670 years (sample Y-129-A). The discrepancy between this figure and that of 1800 ± 150 years obtained on a portion of the same specimen by Kulp *et al.* ([*5*], sample L-129) may arise from the fact that the carbon correction was not applied to the Lamont analysis. The revised date points even more definitely to the probability that *Dinornis*, like *Euryapteryx*, was contemporary with primitive men and was exterminated by them. The inorganic fraction of the same sample, Y-129-B, is the only one of the series in which duplicate determinations are far enough apart to suggest inhomogeneity. This fraction was presumed to be the matrix of the crop contents, but R. C. Murphy, who collected it, admits the possibility that the marl came from a higher level in the excavation and was mixed with the organic remains during packing. The inhomogeneity could be accounted for by the fact that the largest lumps of marl were picked out separately, while hydrochloric acid was then used to make a chemical separation of the calcareous and organic carbon of the remainder. Whether the calcareous and organic fractions differ in age or not depends on the assumptions, and cannot be decided.

The anomalously great age of the wood, sample Y-144-5, could be accounted for if the wood originally grew in the swamp that produced the peat, but found a false stratigraphic position later. It might have been kicked into such a position by a moa, not necessarily from directly below, but from the margin of the lake basin, where the marly deposit is thinner and the peat therefore lies closer to the surface. There is evidence that the moa remains drifted through the mud after the birds were trapped (*18*), and it would seem that wood could have done so too. Assuming that the wood was in fact contemporary with the peat (sample

TABLE 3

DATES FROM PYRAMID VALLEY, WAIKARI, NORTH CANTERBURY, NEW ZEALAND

Dates based on calcareous material are calculated on the assumption that wood and shell have identical $C^{14}$ contents; values in parentheses assume that modern shell contains 10% more $C^{14}$ than modern wood.

| Sample | Description | Probable age, years |
|---|---|---|
| Y-129-A | Crop contents of a large *Dinornis*, "about 5 ft" in marl of upper lake deposit, collected in 1947 by R. C. Murphy, American Museum of Natural History. A portion of this sample was L-129, dated 1800 ± 150 years by Kulp *et al.* (1952) | 610<br>720<br>Av. 670 |
| Y-129-B | Marl matrix from Y-129-A. Two runs, one of large lumps, other of calcareous remainder, suggest inhomogeneity | 330 (1100)<br>780 (1550)<br>Av. 560 (1330) |
| Y-144-1 | Upper marl, 3 ft., collected in 1952 by R. S. Duff, Canterbury Museum | 2600 (3400)<br>2900 (3700)<br>Av. 2750 (3550) |
| Y-144-2 | Lower marl, 4 ft. 3 in.; collected by R. S. Duff | 3300 (4100)<br>3500 (4200)<br>Av. 3400 (4150) |
| Y-144-3 | Clayey marl from lowest part of upper lake deposit, 5 ft. 3 in.; collected by R. S. Duff | 4300 (5100) |
| Y-144-4 | Peat underlying upper lake deposit, 6 ft. 3 in.; collected by R. S. Duff | 3900<br>3400<br>Av. 3650 |
| Y-144-5 | Wood, embedded in marl between upper and lower samples, 3 ft. 11 in.; collected by R. S. Duff | 3300<br>3900<br>Av. 3600 |

Y-144-4), we have evidence that the date of the peat is correct; the aquatic plants of the peat might have incorporated some fossil carbon from the water, but the wood must have obtained its carbon from the air. The confirmation of the age of the peat, suggested to be Sub-Boreal on the basis of the pollen sequence, is the most important result of the study from the stratigraphic point of view. However, lack of knowledge of isotope equilibria in lakes and in the sea presents a more challenging problem to $C^{14}$ dating at present than does late-Pleistocene stratigraphy, and since the modern value to which ancient carbonate carbon should be referred is no longer obvious, we intend to continue the methodologic attack.


**References**

1. Libby, W. F., Anderson, E. C., and Arnold, J. R. *Science*, **109**, 227 (1949).
2. Anderson, E. C., Arnold, J. R., and Libby, W. F. *Rev. Sci. Instruments*, **22**, 225 (1951).
3. Libby, W. F. *Radiocarbon Dating*. Chicago: Univ. Chicago Press (1952).
4. Kulp, J. L., Feely, H. W., and Tryon, L. E. *Science*, **114**, 565 (1951).
5. Kulp, J. L., Tryon, L. E., Eckelman, W. R., and Snell, W. A. *Science*, **116**, 409 (1952).
6. Crane, H. R. *Nucleonics*, **9** (6), 16 (1951).
7. Anderson, E. C., and Levi, Hilde. *Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd.*, **27** (6) (1952).
8. Anderson, E. C., and Libby, W. F. *Phys. Rev.*, **81**, 64 (1951).
9. Craig, H. *Geochem. Cosmochem. Acta*, **3**, 53 (1953).
10. Godwin, H. *Am. J. Sci.*, **249**, 301 (1951).
11. Baertschi, P. *Nature*, **168**, 288 (1951).
12. Wickman, F. E. *Geochem. Cosmochem. Acta*, **2**, 243 (1952).
13. Arnold, J. R. *Soc. Amer. Archaeol., Mem.* **8**, 58 (1951). (*Amer. Antiq.*, **17**, No. 1, pt. 2.)
14. Deevey, E. S. *Canterbury Mus., Rec.* In press.
15. Cranwell, L. M., and von Post, L. *Geograf. Ann.*, **18**, 308 (1936).
16. Firbas, F. *Spät- und nacheiszeitliche Waldgeschichte Mitteleuropas nördlich der Alpen*. Band I: *Allgemeine Waldgeschichte*. Jena: Gustav Fischer (1949).
17. Duff, R. *Canterbury Mus., Bull.*, **1** (1950).
18. ———. *Canterbury Mus., Rec.*, **4**, 330 (1941).


# Copenhagen Natural Radiocarbon Measurements, I.[1]


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CONSTRUCTION of a $C^{14}$ dating apparatus in Copenhagen began in the fall of 1951, and the first unknown samples were dated in the summer of 1952. The technique used is largely that developed by Anderson, Arnold, and Libby (*1*) and later modified by Kulp (*2*). The only significant deviation from the classical set up is the use of a double screen wall counter as described by Anderson and Levi (*3*). This instrument (Fig. 1) consists of two independent detector units in a common envelope and a triple sample cylinder. The sample is mounted on the middle section of the cylinder, while the two outer sections provide the areas for the background countings. As in the conventional screen wall, the positions of the sample cylinder can

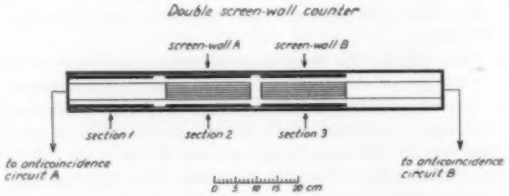


FIG. 1.

be alternated between two extremes. In one position, the sample on the middle section is exposed to detector A and a background area to detector B (cf. Fig. 1); in the other position, the sample is exposed to B and the other background to A. This arrangement has two advantages. First, the counting time necessary to arrive at a given statistical accuracy is reduced by ½, and second, background and sample counts are registered simultaneously, whereby the effect on the net count of possible temporal fluctuations in the background is eliminated. The overall length of the screen


[1] The authors wish to express their gratitude to the Carlsberg Foundation for sponsoring the construction of the dating apparatus and the pertaining equipment. The series of investigations presented here were likewise carried out with financial support from the Carlsberg Foundation. Moreover, our sincere thanks are due Professor P. Brandt Rehberg, head of the Zoophysiological Laboratory where the apparatus is installed, for the hospitality granted and for his kind interest in the work. Several firms have aided the project by placing equipment or chemicals at our disposal at a reduced price or free of charge. We wish to express our appreciation to Brüel and Kjær, Copenhagen, for electronics equipment; Norsk Hydro, Oslo, for supplying argon gas; British Petrol Co., Copenhagen, for supplying butane gas; Det Danske Stålvalseværk, Frederiksværk, for the steel plates forming the shield; and Radiation Counter Laboratories, Skokie, Ill., for a set of 24 a-c counters.


[2] On leave of absence from the Los Alamos Scientific Laboratories. A fellowship and travel grant from the Danish Rask Ørsted Fond and a grant in aid from the Wenner Gren Foundation for Anthropological Research are gratefully acknowledged.

TABLE 1

| Sample No. | Material | Date | Net cpm | Mean |
|---|---|---|---|---|
| K— 5 | Coke | 2/28/52 | $-0.15 \pm 0.14$ | |
| K— 7 | " | 3/6/52 | $-0.14 \pm 0.06$ | |
| K—13 | " | 6/10/52 | $-0.20 \pm 0.08$ | |
| K—14 | Coal | 9/14/52 | $-0.09 \pm 0.08$ | |
| K—20 | " | 1/30/53 | $-0.11 \pm 0.06$ | $-0.13 \pm 0.04$ |
| K— 3 | Contemporary pine | 3/1/52 | $5.76 \pm 0.09$ | |
| K—10 | " birch | 4/20/52 | $6.06 \pm 0.12$ | |
| K—11 | " birch | 5/1/52 | $5.79 \pm 0.20$ | |
| K—12 | " beech | 5/24/52 | $5.94 \pm 0.14$ | $5.88 \pm 0.06$ |
| K—15 | Contemporary beech | 9/23/52 | $5.55 \pm 0.08$ | |
| K—16 | " pine | 9/30/52 | $5.74 \pm 0.06$ | |
| K—19 | " pine | 1/13/53 | $5.65 \pm 0.07$ | $5.66 \pm 0.04$ |

wall counter is 35 in., the diameter 3 in. The counter is shielded by 8 in. of iron on all sides.

The samples measured for calibration are listed in Table 1. "Dead" (inactive) samples consistently turned out slightly negative. This may be due either to a minor radioactive contamination of the sample cylinder, which is suppressed by the carbon sample, or to the reduction in diameter of the sensitive volume of the counter. With a background of 5.8 cpm, the mean decrease in the count found with a "dead" sample in position corresponds fairly well to the reduction in diameter of 1.5%. A correction for this effect has been made in all cases listed below.

Samples of contemporary wood measured during the summer of 1952 gave $5.88 \pm 0.06$ cpm above background. A series of contemporary samples measured during the following period seems to indicate a minor decrease in this value to $5.66 \pm 0.04$ cpm, which may be caused by lower efficiency of the counter. The difference between the two mean values for modern wood is just at the limit of the statistical uncertainty. It was considered safest to reckon with two values for modern wood and to calculate the unknown samples according to the modern wood value measured during the respective period. Therefore, the Ruds Vedby series (Table 2) is calculated on the basis of 5.88 cpm for modern wood, while the value of 5.66 cpm has been used to calculate the Bølling series. The value of 5.88 cpm obtained for modern wood is somewhat lower than the values reported by Kulp (*4*) and Libby (*5*) for the same chemical treatment ($HNO_3$ extraction).

After demounting, all carbon samples were analyzed for their carbon content and the dates were corrected accordingly. Libby (5) has pointed out that the carbon content of the samples can vary even though their ash content is below 1% in all cases. The first samples measured in this laboratory showed variations from 83% to 93% C. After the introduction of a more uniform extraction procedure, the variations so far observed were within 88–91% C. Adsorption to the carbon powder of varying amounts of volatile material (mainly water vapor) may account for the differences.

Table 2 gives the age determinations obtained for a series of geological samples. The calculation is based on a half-life for $C^{14}$ of $5568 \pm 30$ years (*6*). The errors reported are standard deviations of the counting data; all figures given represent separate runs. All samples are from the late glacial period known as the Allerød oscillation. These measurements are the first in a series of investigations aiming at the establishment of a direct connection between results obtained by means of the radiocarbon method and that of pollen analysis.[3] In the course of these investigations, it is intended to date some of the most characteristic horizons in the European pollen diagrams in the absolute time scale. The measurements presented here give the age of the sharp transition (Birch fall) in the pollen diagrams between Allerød (pollen zone II) and Younger Dryas (pollen zone III).[4] All samples are taken from lake and bog deposits. The Ruds Vedby series is from a calcareous site on Zealand, the Bølling series from a noncalcareous site in Jutland. Sample K—107, dated to $11.160 \pm 320$, is interesting from the viewpoint of interlaboratory check, as it is identical (half of the original sample) with Libby's sample 337 which was dated to $11.044 \pm 500$ (*7*).

The results obtained on samples taken in or a trifle underneath the transition period between Allerød and Younger Dryas and which, from a radiocarbon point of view, are simultaneous, are plotted in Fig. 2. The scattering of the dates around the mean value is in

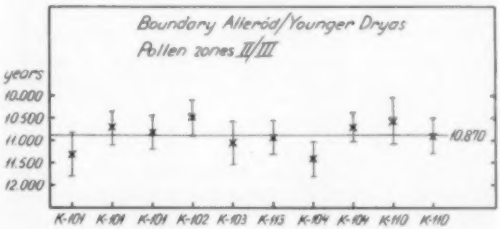


FIG. 2.

[3] Cf. Knut Faegri and Johs. Iversen. *Textbook of Modern Pollen Analysis*, Copenhagen (1950).

[4] The samples suited for $C^{14}$ dating are chosen by a committee consisting of Th. Mathiassen (chairman), H. Larsen, and J. Troels-Smith from the National Museum, and S. Hansen and J. Iversen, from the Danish Geological Survey (D.G.U.).

TABLE 2

GEOLOGICAL SAMPLES

| Sample No. | Description* | Age (years) |
|---|---|---|
| | *Ruds Vedby series* | |
| K—101 | Boundary Allerød period (II)/Younger Dryas period (III). Wood taken from a thin, dark, synchroneous stripe No. 4 in an open profile at Ruds Vedby, Zealand, Denmark. This stripe represents the exact zone boundary II–III D.G.U. 5b. The wood was isolated from the peaty lake mud of the following sample K—102. Submitted by Johs. Iversen. | 11.310 ± 500<br>10.720 ± 380<br>10.820 ± 370<br>Av. 10.890 ± 240 |
| K—102 | Boundary Allerød/Younger Dryas. Peaty lake mud from stripe No. 4 mentioned above. D.G.U. 5d. Submitted by Johs. Iversen. | 10.500 ± 400 |
| K—103 | Boundary Allerød/Younger Dryas. Calcareous lake mud taken from a 1-cm-thick layer underneath the dark peaty stripe No. 4. Pollen zone boundary II–III. Submitted by Johs. Iversen. | 11.060 ± 480 |
| K—113 | Allerød. Lake marl underneath samples K—101, 102, 103, above dark stripe No. 6. Position: The very end of the Allerød maximum (zone IIb), a trifle underneath the Allerød boundary (II–III). D.G.U. 8. Submitted by Johs. Iversen. | 10.930 ± 380 |
| K—104 | Allerød. Calcareous lake mud from dark stripe No. 6. Position a little underneath the Allerød boundary (II–III). D.G.U. 10. Submitted by Johs. Iversen. | 11.410 ± 390<br>10.700 ± 310<br>Av. 10.990 ± 240 |
| K—105 | Allerød. Calcareous lake mud from dark stripe No. 7, slightly above the middle of Allerød. D.G.U. 13. Submitted by Johs. Iversen. | 11.800 ± 410 |
| K—106 | Allerød. Lake marl slightly below the middle of Allerød. D.G.U. 14. Submitted by Johs. Iversen. | 11.710 ± 410<br>12.180 ± 620<br>Av. 11.880 ± 340 |
| K—114 | Lime isolated from sample No. K—113 D.G.U. 8. This sample was measured in order to trace a possible difference between the age of the carbon in the organic and the carbonate fraction of the samples, respectively. The difference seems sufficiently small to indicate that a possible intrusion of the carbonate carbon into the organic carbon of the samples is of little significance for the dating results. | 12.280 ± 480 |
| | *Bølling series* | |
| K—111 | Younger Dryas. Noncalcareous lake mud from the boundary between pollen zones III and IV. The sample is from a noncalcareous site at lake Bølling, Silkeborg, Jutland. D.G.U. 37. Submitted by Johs. Iversen. | 10.300 ± 350 |
| K—110 | Boundary Allerød/Younger Dryas. Lake mud (noncalcareous) from a 1–1.5 cm thick layer 50 cm underneath sample K—111. D.G.U. 38a. Submitted by Johs. Iversen. | 10.890 ± 380<br>10.550 ± 520<br>Av. 10.770 ± 300 |
| K—112 | Allerød. Noncalcareous lake mud from other section. Stratigraphical position not yet exactly determined. D.G.U. 42a and 42b. Submitted by Johs. Iversen. | 11.790 ± 480<br>11.600 ± 530<br>Av. 11.700 ± 360 |
| | *Hannover sample* | |
| K—107 | Allerød. Peaty lake mud from pollen zone II, at Wallensen im Hils, Hannover, Germany. The sample is identical with Libby's No. 337, which was dated to 11.044 ± 500 years. Submitted by F. Firbas. | 11.160 ± 320 |

* The datings were carried out on the organic fraction of the sample.

agreement with statistics. As the original samples are of different chemical composition (wood, peaty mud, lake-marl), collected in sites more than 200 miles apart, the internal consisteney of the results presented here seems to make the occurrence of noticeable exchange with carbon of different specific activity, or intrusion of other radioactive species improbable.

Most determinations are made on samples of gyttja (lake-mud) which consists of a variety of remains of water plants, plankton, bacteria, limnic invertebrates, together with land plants, leaves, etc. deposited in the lake. The contemporary specific activity of this material is not exactly known and may vary from place to place. Craig (*8*) has shown that the $C^{13}$ content of organic carbon in marine plants and marine invertebrates is about 1% higher than that of wood and land plants. The $C^{14}$ content thus might be 2–3% higher and a similar effect may be found for fresh water plants. It should, however, be taken into account that not all organic material deposited as lake

mud is of limnic origin and that the specific activity of water plants may depend on whether they photosynthesize $CO_2$ from the air and $CO_2$ dissolved in the water, or they photosynthesize bicarbonate. In view of these considerations, the mean specific activity for this group of material was tentatively taken to be 1% higher than the corresponding value for wood.

On the basis of these assumptions the mean age determination of the samples from the transition period between Allerød and Younger Dryas, as shown in Fig. 2, is calculated to be 10.870 ± 130 years. With an error in the mean value of this magnitude, however, the uncertainties in the determination of the half-life of $C^{14}$ and of the value for modern wood are no longer negligible. If this is taken into account, the date becomes 10.870 ± 160 years.

### References


1. Anderson, E. C., Arnold, J. R., and Libby, W. F. *Rev. Sci. Inst.*, **22**, 225 (1951).
2. Kulp, J. L., Tryon, L. E., and Feely, H. W. *Trans. Am. Geophys. Union*, **33**, 183 (1952).
3. Anderson, E. C., and Levi, Hilde. *Dan. Mat. Fys. Medd.*, **27**, No. 6 (1952).
4. Kulp, J. L., Feely, H. W., and Tryon, L. E. *Science*, **114**, 291 (1951).
5. Libby, W. F. Private communication.
6. Libby, W. F. *Radiocarbon Dating*. Chicago: Univ. Chicago Press (1952).
7. Arnold, J. R., and Libby, W. F. *Science*, **113**, 111 (1951).
8. Craig, H. *Geochim. et Cosmochim. Acta*, **3**, 53 (1953).


# Radiocarbon Dating of the Alleröd Period


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THE AIM of the first radiocarbon assays in Copenhagen[1] is the dating of the late glacial Alleröd period, and, at the same time, a check of the applicability of certain material taken from sediments of various types.

The Alleröd period covers a great, late glacial, climatic fluctuation first demonstrated at Alleröd in North Zealand by Hartz and Milthers in 1901 (*1*). In the clay walls of the brickwork at Alleröd, we find a continuous band of pure organogenic lake mud, containing remains of a temperate flora and dividing the clay into an upper and a lower bed. Both beds are characterized by Arctic plant fossils, e.g., Dryas octopetala. Obviously, the mud layer represents a mild phase, the Alleröd period (Zone II), interposed between two cold periods, the Older Dryas Period (Zone I), and the Younger Dryas Period (Zone III). This classical Alleröd section has since been found in numerous other places in Denmark (e.g., Ruds-Vedby, Fig. 1). The same climatic development can be demonstrated by pollen analysis everywhere in Danish late glacial series, even where the stratigraphy is different.

In later years, the Alleröd oscillation has been alleged in many other countries in northwestern Europe and also in the Alps. In North America, a late glacial bed containing tree trunks that have succumbed to a new advance of the ice (Two Creeks Forest bed [*2*]) has been compared with the Alleröd section. A proof that a local climatic oscillation in late glacial times is part of a universal development, identical with the Alleröd period, can be furnished only by an unambiguous demonstration of the synchronism of these events. For the time being, the only means of absolute dating is the radiocarbon method. It there-

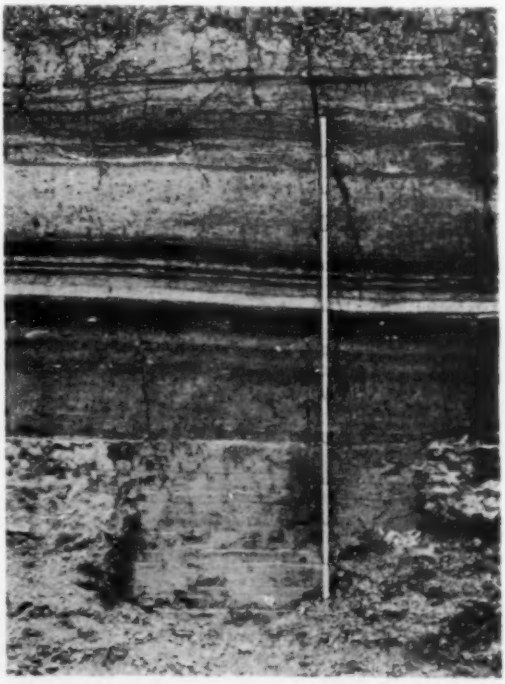

Fig. 1. Part of Alleröd section at Ruds-Vedby. Clay above and beneath: layers of organogenic lake mud (dark) and lake marl (white) in the middle cover the Alleröd period.

[1] Cf. the paper by Anderson, Levi, and Taüber, "Copenhagen Natural Radiocarbon Measurements," also in this issue.

fore is of great interest to carry out an absolute dating of the Alleröd oscillation in the classical Danish region and subsequently compare these dates with datings from other supposed Alleröd beds.

For the purpose of establishing a reference, samples from an exposed Alleröd section at Ruds-Vedby in Zealand were taken. Here, the Alleröd stratigraphy presents itself in the classical form as a layer of organic lake mud interposed between two thick layers of clay (Fig. 1). The section is characterized by a distinct layering, each of the thin layers being synchronous. The composition of the layers varies greatly, and therefore it has been possible to procure material of different types, viz., wood, peat mud, and lake marl.

Figure 2 is a pollen diagram from the location where the $C^{14}$ samples were taken. To make the figure comprehensible for nonspecialists in this field the details have been omitted from the diagram.[2] Only the fluctuating frequency of trees, shrubs, and herbaceous plants is given. It appears from the diagram that while pollen of herbaceous plants (indicating the tundra) dominate in the Older and Younger Dryas clay (Zones I and III), the Alleröd deposits (lake mud and lake marl) are characterized by the preponderance of tree pollen; this is evidently true in the lake marl which, in this case, represents the climatic optimum (Zone IIb). The following decline is indicated by the abrupt fall in the tree-pollen frequency and the corresponding rise in pollen frequency of herbaceous plants.

This horizon—the zone border II–III—is the sharpest horizon in the Danish pollen diagrams and is definitely synchronous. For this reason, we have made a great effort to arrive at an exact date of this horizon. The mean of 5 determinations (K-101A, B, C; K-102; and K-103) is 10,830 ± 200 years; this figure, therefore, represents the age of the upper limit of the Alleröd period.

K-106 (11,880 ± 340) is from the very end of Zone IIa, the early part of Alleröd, immediately before the climatic optimum was reached. If this figure is compared with the dating of the zone border II–III, we notice a difference of about 1000 years. Although the statistical error of the results is considerable, we can conclude on the basis of these radiocarbon datings, that the Alleröd period covers at least one millennium.

All the deposits in the Ruds-Vedby section are rich in lime, and this may cause intrusion of carbon of different age. Besides the free $CO_2$, dissolved bicarbonate may also be an immediate source of carbon for submerse aquatic plants during photosynthesis. Some of the carbon in the bicarbonate of Danish lakes derives from free $CO_2$, some, however, from pre-Quaternary chalk. While the former will have the specific activity of the exchange reservoir, the latter will be practically inactive; yet exchange processes will tend to produce a specific activity corresponding to that prevailing in water in equilibrium with the atmosphere. If this exchange is a slow process, submerse plants from lakes rich in lime will show a considerable deficiency in $C^{14}$. Radiocarbon datings from calcareous lake deposits will then turn out too old.

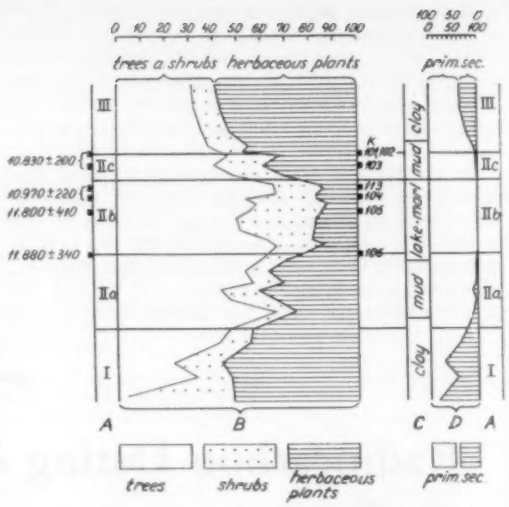


FIG. 2. Pollen diagram from the center part of the Alleröd section at Ruds-Vedby. A. The zoning system according to Knud Jessen (I Older Dryas period, II Alleröd period, III Younger Dryas period). B. Total pollen diagram; all individual pollen curves have been omitted. C. Stratigraphy. D. The frequency of secondary pollen, i.e., pollen deriving mainly from old, pre-Quaternary deposits, and washed in from pollen containing boulder clay. This influx indicates unfavorable climatic conditions, and the Alleröd-oscillation is reflected in the curve of secondary pollen (*10*).

This problem has been studied by comparing the result of radiocarbon measurements on sample K-113 (lake marl) with those of K-101 (wood) and K-110 (noncalcareous lake mud). According to pollen analysis, these three samples are almost contemporaneous. Samples K-101 and K-113 are from Ruds-Vedby (Fig. 2); K-110 is from an Alleröd section located in a very poor outwash-plain in Jutland, near the former Bölling lake. K-110 derives from a thin peaty mud layer; pollen analysis classifies it as being from the boundary between Zones II and III. The results obtained are as follows:

| | | |
|---|---|---|
| K-113 | Lake marl | 10,930 ± 300 |
| K-101 | Wood | 10,890 ± 240 |
| K-110 | Noncalcareous lake mud | 10,770 ± 300 |

The fact that these figures are identical within statistical error shows that radiocarbon measurements of highly calcareous lake sediments can give reliable dates.

The sample K-114 is from the same material as K-113; but while K-113 represents a measurement carried out on organic matter, K-114 is made on lime isolated from the same material. The figure for K-114 is somewhat higher (12,280 ± 480), which seems to indicate that equilibrium with the exchange reservoir was not yet reached when the lime was precipitated.

[2] The pollen analyses have been carried out by H. Krog; the detailed pollen diagram will be published elsewhere.

On the other hand, the difference seems sufficiently small to confirm that in this sample, intrusion of carbonate-carbon into organic matter is of little significance for the dating results (cf. Anderson, Levi, and Tauber, this issue).

K-111 (10,300 ± 350) from the Bölling section dates the boundary between the late glacial and postglacial period, the zone border III–IV, which is characterized by a rapid spreading of the forest as the result of considerable climatic improvement. It is generally assumed that this event is synchronous with the final retreat of the ice from the central Swedish moraines. From this period, we have the oldest fairly reliable date which is based on the Swedish varved clay chronology, viz., 10,060 prior to our time (*3*). It is remarkable how well the radiocarbon dating of the zone border III–IV (K-111: 10,300 ± 350) agrees with this date, especially in view of the fact that the varved clay chronology has a considerable margin of error. The weak point in the dating is that it depends on the linkage of a varve chronology covering the early end of the scale (*3*) with another one covering the later end up to our time (Liden). If there is a gap between these scales, as suggested by Sauramo (*4*), the date given above (about 10,060 years) is too low. The agreement between the results obtained earlier and our radiocarbon date, however, seems to indicate that the gap is smaller than supposed by Sauramo.

Finally, the sample K-107[3] is from a profile at Wallensen in Hannover (Germany), which has been attributed to the Alleröd period by Firbas (*5*) owing to a very similar stratigraphy and pollen diagram. A sample from the upper part of the mud layer, corresponding to our Zone IIb, has been dated by Arnold and Libby (*6*); the figure (11,044 ± 500) is in perfect agreement with the new Danish dating (11,160 ± 320). A comparison with the radiocarbon dates from Rudsvedby proves that Firbas correctly referred the Wallensen mud layer to the Alleröd period (*7*).

[3] This sample was submitted by Firbas and the material is identical with that dated by Libby.

From the British Isles radiocarbon datings from four supposed Alleröd localities are available.

| | | |
|---|---|---|
| No. 355 | Lake mud at Knocknaeran, County Monaghan, Ireland (F. Mitchell) | 11,310 ± 720 |
| No. 444 | Lake mud from Neasham near Darlington, Northumberland, England (H. Godwin and K. Blackburn) | 10,851 ± 630 |
| No. 341 | Peat from Hawks Tor, Cornwall (H. Godwin) | 9,861 ± 500 |
| No. 349 | Calcareous silty neeron mud, Hockham Mere, Norfolk (H. Godwin) | 6,555 ± 280 |

Godwin (*8*) has discussed these datings thoroughly. The sample 349 should be disregarded because the material was collected using a rather unsafe method (*8*). The date of No. 341 is somewhat too low for Alleröd, but the pollen analysis from the peat (cf. [*9*], Tables 6–7), in the present author's opinion, does not exclude the possibility that the material was deposited during the Younger Dryas period (Zone III); this is fairly consistent with the result of the $C^{14}$ dating.

The geological classification of the Irish section (No. 355) and of the section in Northumberland (No. 444), however, is very convincing as belonging to the Alleröd period. These classifications are indeed confirmed by the radiocarbon dating.

The synchronization of the Two Creeks forest bed (cf. above) in the U.S. with the Alleröd period already seemed highly probable on the basis of the radiocarbon datings published by Arnold and Libby (*6*); the new dates from the Danish Alleröd strata finally settle the question. The mean of 5 datings on material from Two Creeks is 11,400 ± 350 (*6*), while the Alleröd period according to the Danish dates, ranges from about 12,000 to 10,800 years prior to our time. The great importance of this transatlantic correlation has already been discussed by Flint and Deevey (*11*). The Alleröd oscillation now appears to be universal, at least in the Northern Hemisphere.

## References


1. Hartz, N., and Milthers, V. *Dansk geol. Foren. Medd.*, **8**, 7 (1901).
2. Wilson, L. R. *Trans. Wisconsin Acad. Sci.*, **27**, 31 (1932).
3. De Geer, G. *Kgl. Svenska Vetenskapsakad. Handl.*, **18**, No. 6 (1940).
4. Sauramo, M. *Soc. Sci. Fennica*, **27**, B, No. 4 (1949).
5. Firbas, F. *New Phytologist*, **49**, 163 (1950).
6. Arnold, J. R., and Libby, W. F. *Science*, **113**, 111 (1951).
7. Firbas F. *Naturwissenschaften*, **40**, H2, 54 (1953).
8. Godwin, H. *Am. J. Sci.*, **249**, 301 (1951).
9. Conolly, A. P., Godwin, H., and Megaw, E. M. *Roy. Soc. London, Phil. Trans.*, **B234**, 397 (1950).
10. Iversen, Johs. *Danmarks Geol. Undersøgelse*. IV, R., **2**, No. 15 (1936).
11. Flint, R. F., and Deevey, E. S. *Am. J. Science*, **249**, 257 (1951).

# *News and Notes*

## Association of Southeastern Biologists

THE 14th annual meeting of the Association of Southeastern Biologists was held April 16–18, 1953, at the University of North Carolina, Chapel Hill, with 270 biologists in attendance from throughout the Southeastern states. L. C. Dunn of Columbia University presented the annual evening address of the association, and three prizes were awarded to southern scientific workers. The Carolina Biological Supply Company prize of $100 for the best paper presented at the annual meeting in competition for this prize was awarded to Daniel Billen, B. F. Strehler, and George Stapleton, for their paper on the post-irradiation release of adenosinetriphosphate (ATP) from irradiated bacteria (*E. coli*). The authors are members of the staff of the Biology Division, Oak Ridge National Laboratory. The annual award is made on the basis of papers judged by prominent biologists each year. Honorable Mention award for second place went to H. E. Wheeler of the Louisiana State University for his paper on the genetics and cytology of a mutant fungus, *Glomerella*.

The annual award of merit made each year to a Southeastern teacher on the basis of his contribution to the students of the South and to his university was made to Orlin D. White, Director of the Blandy Experimental Farm, University of Virginia. The annual award, which is made each year for a fellowship at the Mountain Lake Biological Station of the University of Virginia, went to Herman Silva of Knoxville, Tennessee, for his study of southeastern algae.

Also meeting in association with the southeastern biological group were two more specialized societies interested in southern regions. These were the Southern Appalachian Botanical Club, and the Southeastern Section, Botanical Society of America. A. J. Sharp of the University of Tennessee became the new Chairman of this botanical group, F. T. Wolf of Vanderbilt University was elected Secretary, and H. E. Wheeler of the Louisiana State University was elected Chairman of the Activities Committee.

Elections in the Association of Southeastern Biologists were as follows: Bruce D. Reynolds, Miller School of Biology, University of Virginia, advanced to President from the previous position of President-Elect. The new President-Elect is H. R. Totten, Department of Botany, University of North Carolina, Chapel Hill. Vice-President, Alvin Beatty, Department of Biology, Emory University; Treasurer, J. Paul Reynolds, Department of Zoology, Florida State University, Tallahassee; Mary Esther Gaulden of the Oak Ridge National Laboratory continues as Secretary. New additions to the Executive Committee are H. H. Hobbs of the University of Virginia, Gordon Walcott, United States Public Health Service, Columbia, South Carolina, and John Fincher, of Howard College, Birmingham, Alabama. It was announced that the Association will meet in 1954 at the Louisiana State University, Baton Rouge.

## Scientists in the News

**Everett M. Bens,** formerly microanalyst for the Shell Oil Company's Wood River research laboratories, has joined Truesdail Laboratories, Los Angeles. He is in charge of Truesdail's new microanalytical laboratory.

**John Twiss Blake,** Director of Research at the Simplex Wire & Cable Co., Cambridge, Mass., has won the 1953 Charles Goodyear Medal, highest honor in rubber chemistry. The Goodyear Award, founded in commemoration of Charles Goodyear's discovery of the vulcanization of rubber in 1839, is conferred annually by the American Chemical Society's Division of Rubber Chemistry to stimulate interest in fundamental research in rubber and to honor those who have performed outstanding service to rubber science. Co-editor of the American Chemical Society monograph *Chemistry and Technology of Rubber,* Dr. Blake has published many scientific articles dealing with the reinforcement of rubber, the thermochemistry of rubber vulcanization, the effects of light and ozone on rubber deterioration, the heat of vulcanization of synthetic rubber, water absorption by rubber, and the effect of soil microorganisms on rubber insulation. He holds patents on the preserving of rubber, rubber coatings on electrical connections, and low plasticity rubber.

**Eugene C. Bovee,** Acting Chairman of the Department of Biology and Zoology at North Dakota Agricultural College, has resigned to accept a position as Assistant Professor of Biology at the University of Houston. He will teach upper division and graduate courses in physiology.

**John G. Burr,** staff member of the Oak Ridge National Laboratory Chemistry Division, will leave in July for a year's study at the University of London, England. He has been awarded a special fellowship granted by the U. S. Department of Public Health and under the sponsorship of the National Cancer Institute. During his leave of absence Dr. Burr will conduct research in theoretical organic chemistry. He also plans to write a book, for which the publisher's contract has already been negotiated, on the use of isotopes in organic reaction mechanisms.

**William R. Burwell,** Vice Chairman of the Clevite Corporation and President of the Brush Electronics Co., Cleveland, has been appointed to the Board of Directors of Stanford University's Stanford Research Institute. Dr. Burwell is a graduate of Brown Uni-

versity, where he once taught mathematics and where he is at present a member of the Board of Fellows and of the Executive Committee. He was a Rhodes Scholar at Oxford University and in 1921 received the first Oxford Ph.D. awarded to an American.

**William W. Coblentz,** retired National Bureau of Standards physicist, has received the second Annual Award of the Society for Applied Spectroscopy in recognition of his pioneering work in infrared spectroscopy. Dr. Coblentz's fundamental research in this field laid the foundation for present methods for the analysis of large, complex organic molecules. Almost a half century ago Dr. Coblentz made extensive investigations of previously unexplored regions of the infrared spectrum and correlated the characteristics of the spectra he obtained with chemical composition and purity. Today's infrared absorption techniques are based on the results of his original work and are used almost universally in such fields as petroleum, plastics, rubber, and textiles for purposes ranging from plant control to investigations of molecular structure. Dr. Coblentz is also well-known for his work in astrophysics.

**O. Boyd Houchin** has been appointed Assistant Professor of Neurology at the University of Arkansas School of Medicine, effective July 1. Dr. Houchin will study the biochemistry of the brain in connection with a project now in operation in the Department of Neurology under the sponsorship of the United Cerebral Palsy Association of America.

**Francis L. Mead,** who was responsible for many improvements in the current processes used for production of citric acid by Chas. Pfizer & Co., recently has retired from that firm after an association dating back to 1920. During his career with Pfizer Mr. Mead served as Manager of Citric Acid Recovery and more recently as New Product Manager. A specialist in citric acid production, he has assisted firms in Europe and Canada in the construction of citric acid facilities.

**Rachael La Roe,** head of mathematics and physics at Grand Canyon College, Arizona, has been named Associate Professor of Mathematics and Physics at Mary Hardin-Baylor College, Belton, Texas, effective next September.

**LeRoy Scharon,** Associate Professor of Geology, Washington University, St. Louis, has been appointed to the Executive Committee of the Mining, Geology, and Geophysics Division of the American Institute of Mining and Metallurgical Engineers. He was elected Chairman of the Mining Branch and a member, ex officio, of the Board of Directors for the year 1953.

Two new faculty members will join the Division of the Geological Sciences at the California Institute of Technology this fall. **Francis G. Stehli,** who has just received a Ph.D. from Columbia University, becomes Assistant Professor of Invertebrate Paleontology, and **Thane McCulloh** will be Assistant Professor of Geology. Dr. McCulloh received his doctorate in geology from the University of California last year.

**Robert Straus,** Research Associate in applied physiology at Yale University, has been appointed Assistant Professor in the Department of Public Health and Preventive Medicine at the College of Medicine, State University of New York, Syracuse. Dr. Straus has made extensive studies in the field of alcoholism.

**Richard Wellington,** Head of the Division of Pomology of the New York State Agricultural Experiment Station at Geneva, retired July 1st after 47 years of fruit breeding and horticultural research, 40 years of which were spent at the Experiment Station in Geneva. He is credited with more than 70 new varieties of fruits, many of which are now standard commercial varieties. He was the recipient of the gold medal of the Massachusetts Horticultural Society and the Society's Jackson Dawson medal for contributions to fruit breeding.

**Sir Hubert Wilkins,** Australian-born Arctic explorer, has been appointed a geographer in the Research and Development Division of the U. S. Army Quartermaster Corps.

## Education

Fifteen scientific, industrial, and educational leaders have been named to a new advisory board created to assist the Institute of Mathematical Sciences of **New York University** to develop its facilities and to advise on problems of operation and administration. The Institute represents an expansion and integration of advanced research and instruction in the mathematical sciences. A major facility in the new Institute, created in January, will be a computing center for the Atomic Energy Commission, including the $880,000 Univac #4 now being installed. David D. Henry is administrative director and Richard Courant is scientific director of the Institute.

Retiring from the staff of the **Ohio State University** this summer are: Herman G. Heil, Associate Professor of Physics; Clyde H. Hebble, Professor of Operative Dentistry; Franklin W. Marquis, Professor of Mechanical Engineering; Frederick J. Salter, Associate Professor of Agronomy; Dick P. Snyder, Professor of Oral Surgery and Anesthesia; J. I. Falconer, Professor of Agricultural Economics and Rural Sociology; Harry M. Beatty, Assistant Professor of Mathematics; Arthur M. Brant, Associate Professor of Mineralogy; and Thomas L. Kibler, Professor of Economics. Alma L. Garvin, Professor of Home Economics, retired earlier this year.

The Institute of Industrial Health of the **University of Cincinnati** announces a course of instruction in Occupational Skin Problems, to be presented jointly by the Division of Occupational Health of the Public Health Service, the Department of Preventive Medi-

cine and Industrial Health, and the Department of Dermatology and Syphilology. The course, to be given Oct. 12–16, is designed to give physicians a greater understanding of cutaneous problems of occupational origin. Louis Schwartz, former Chief, Industrial Dermatoses Section, USPHS, will be guest speaker at the dinner meeting, and will describe his experience with problems of industrial dermatoses during the past 25 years. Further information is available from the Secretary, Institute of Industrial Health, Kettering Laboratory, Eden and Bethesda Aves., Cincinnati 19, Ohio.

**Wayne University** will conduct a $15,000 study of hydrocortisone for the Department of the Army. The one-year project will be directed by William Q. Wolfson of the College of Medicine, which also received a $5000 grant from the Detroit Memorial Hospital for general research in pathology.

## Grants and Fellowships

The following **AAAS Research Grants** have been awarded: Colorado-Wyoming Academy of Science, to Clark H. Livingston, Collins, Colo., and to Robert J. Potter, Boulder, Colo.; Iowa Academy of Science, to Paul S. Helmick, Drake University, and to Harris Palmer, Parsons College.

The **Chicago Medical School** announced new and renewed research grants recently awarded to: Hans Elias, (a) a renewal of $4000 from the U. S. Public Health Service for study of "The Architecture of the Adrenal Cortex in Normal and Hypertensive Human Subjects," (b) a new grant of $11,600 for a period of two years from the National Cancer Institute for study of "Morphology of Carcinoma of the Liver"; Harold Koenig, $22,000 from the USPHS for "Morphologic and Quantitative Study of the Nucleoprotein in Living Cells Grown in Vitro and the Effect of Noxious Agents"; Aldo A. Luisada, (a) $9700 for study of cardiac murmur, (b) $500 to complete payment on apparatus; Philippe Shubik, a Cancer Teaching Grant in the amount of $25,000, renewed by the National Cancer Institute.

Two new undergraduate scholarships of $800 annually have been established at **Lehigh University**, one by the Bethlehem Globe-Times Foundation, and one by the Atlas Equipment Corporation and Paul B. Reinhold, a 1913 Lehigh graduate. Both funds will be administered through the university committee on scholarships and loans.

The **National Foundation for Infantile Paralysis** has a limited number of fellowships available to psychiatrists interested in the emotional problems of the physically disabled. Appointments will be made for one year, subject to renewal. For further information, write: Division of Professional Education, National Foundation for Infantile Paralysis, 120 Broadway, New York City.

The **National Research Council of Canada** has announced the awarding of three Merck postdoctoral fellowships in the natural sciences to: W. G. B. Casselman, G. D. Fasman, and B. A. Gingras.

The **Theobald Smith Award** of $1000 and a bronze medal, sponsored by Eli Lilly and Company of Indianapolis under the auspices of the AAAS, will be given for the ninth time at the Boston meeting in December. The prize is given for "demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality." Nominations should be sent to Allan D. Bass, Department of Pharmacology, Vanderbilt University School of Medicine, Nashville, Tennessee, before *Sept. 15*. They should be in triplicate and accompanied by full information concerning the nominee's personality, training, and research work. U. S. citizens less than 35 years of age on Jan. 1, 1953, are eligible. Nominations may be made by AAAS Fellows, and the President of the Association and four Fellows will form the committe of award. The last winner was Frank J. Dixon, Jr., of the University of Pittsburgh School of Medicine, for a paper entitled "The Dynamics of Immune Response."

The **Ernest T. Trigg Foundation** has announced the approval of four scholarships for the Paint Chemistry Course conducted at the North Dakota Agricultural College. The four scholarships, to start with the 1953 fall term, make a total of seven grants by the Foundation in the special paint course at N.D.A.C. Detailed information may be obtained from, and applications for the scholarships may be sent to: Dr. Wouter Bosch, Chairman, North Dakota Agricultural College, Fargo, N. D.

The Research Advisory Board of **United Cerebral Palsy** invites nominations for the third annual United Cerebral Palsy—Max Weinstein award for the outstanding recent scientific achievement in the field of cerebral palsy. The award consists of a plaque and $1000. Nominations, accompanied by a short supporting statement, should be in the hands of the Board by *Sept. 15*. Address nominations to Glidden L. Brooks, Medical Director, United Cerebral Palsy, 50 West 57th St., New York 19, N. Y.

## In the Laboratories

The **Cold Spring Harbor Laboratories**—the Department of Genetics of the Carnegie Institution of Washington, and the Biological Laboratory of the Long Island Biological Association—held an opening ceremony May 29 for their new joint lecture hall and the new laboratory buildings of the Department of Genetics. The principal speaker was Vannevar Bush, who spoke of the intricacy and challenge of the biological sciences today and the importance of freedom for fundamental research. Exhibits demonstrating some of the current research problems at the laboratories were presented after the ceremony.

Sherman Ross, Associate Professor of Psychology, University of Maryland, and Freddy Homburger, Research Professor of Medicine, Tufts College Medical School, have been appointed Scientific Associates by the **R. B. Jackson Memorial Laboratory.** The six men who have thus far been given this title by the Laboratory will continue research in their diversified fields at Bar Harbor this summer.

**Olin Industries,** East Alton, Ill., has announced the appointment of the following scientists who will be in the Explosives Division, Research and Development Department: Joseph Allovio, Graduate Chemist; John LaBash, Jr., Assistant Chemical Engineer; Paul S. McKittrick, Assistant Chemist; Melvin B. Morgan, Technical Librarian; Willard Schoeck, Graduate Chemist; and Robert H. Schwaig, Graduate Chemical Engineer.

A new laboratory pilot plant for the recovery of beryl, a rare and critical mineral with many military and industrial uses found in South Dakota's Black Hills, began its first test run June 1 in the **Pegmatite Research Laboratory** of the U. S. Bureau of Mines, Department of the Interior, at Rapid City, S. D. The procedure for the flotation of beryl which is being tested in the laboratory-scale pilot plant was developed by S. M. Runke, Bureau of Mines metallurgist and acting supervisor of the Rapid City Field Office. Although current research is primarily concerned with recovering a satisfactory beryl concentrate, it will also permit research on the separation of mica, feldspar, tantalite, columbite, and numerous other minor but very valuable minerals found in pegmatite.

Beryl is used directly in the manufacture of porcelains for spark plugs. Beryllium oxide goes into making special purpose refractories and into copper-beryllium alloys which in turn make excellent springs, electrical contact points, nonmagnetic ball bearings and nonsparking tools. Beryllium, the metal, is used in X-ray windows and in the atomic energy field as a moderator of fast neutrons.

South Dakota's Black Hills are the Nation's chief domestic source of beryl. Reserves of low-grade beryl total nearly 12,000 tons, according to the U. S. Geological Survey.

In recent years, South Dakota has produced about 100 tons of beryl annually—approximatey 50 per cent of domestic production.

Current production of beryl results entirely from hand-sorting coarsely crystalline sections of only the richest beryl-bearing pegmatite. Maximum recovery of beryl through hand sorting, according to experienced engineers, is no more than 30 per cent with an average recovery of about 20 per cent. Thus 70 to 80 per cent of the beryl encountered in mining is too fine for recovery through hand sorting or is lost for other reasons.

With domestic production small, the United States relies on imports for about 90 per cent of all beryl consumed. In 1950, imports totaled 4683 short tons valued at $1,181,831. They came from Brazil, the Union of South Africa, Southwest Africa, Southern Rhodesia and Mozambique.

## Meetings and Elections

A **Colloquium on Zoological Nomenclature,** scheduled to convene July 29, will immediately precede the 14th International Congress of Zoology, to be held at Copenhagen, Denmark, Aug. 5–12. Officially representing the Society of Systematic Zoology at the Colloquium and Congress will be Curtis W. Sabrosky, Entomologist, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture; Robert L. Usinger, Associate Professor of Entomology, University of California, Berkeley; G. Winston Sinclair, Dept. of Geology and Paleontology, Ohio Wesleyan University, Delaware, Ohio; and W. I. Follett (chairman of the Society's Nomenclature Committee), Curator of Fishes, California Academy of Sciences, San Francisco. Two of these representatives have received grants in aid of travel from the National Science Foundation. Anyone desiring the consideration of particular nomenclatural matters at the Colloquium or Congress is urged to communicate immediately with one of the foregoing delegates or with a member of the International Commission on Zoological Nomenclature.

**Cornell Aeronautical Laboratory** was host on May 20 to a meeting of the Cornell Committee for Transportation Safety Research. The Committee is composed of representatives from Cornell University, the Cornell-Guggenheim Aviation Safety Center and the Medical College in New York, and the Cornell Aeronautical Laboratory in Buffalo. The Committee instigates, promotes, and coordinates research programs in automobile and aviation safety.

A series of short courses in radiological health are again being presented by the Public Health Service at the **Environmental Health Center** in Cincinnati, Ohio. These courses, tuition free, are designed primarily to provide professional personnel working in health departments and other organizations with a working knowledge of the health hazards associated with radiation. Candidates should have a degree in medicine, engineering or science (physical or biological). Instruction is given in radiation physics sufficient for an understanding of the problems arising from proper and improper use of ionizing radiation. Laboratory and lecture periods are presented covering the hazards, and methods of alleviating these hazards, as encountered in employment of x-rays, radioisotopes, neutron fluxes and particle accelerators. Courses are each two weeks in length. Basic Courses, which stress basic radiation physics and survey techniques, will be presented October 5–16, 1953, January 11–22, 1954, and May 3–14, 1954.

The Basic Course or its equivalent is a prerequisite for the Intermediate Course. Laboratory assay of radioelements and x-ray survey techniques are em-

phasized in the Intermediate Course which will be presented October 19–30, 1953, January 25–February 5, 1954, and May 17–28, 1954. Completion of the Intermediate Course or its equivalent is a prerequisite for admission to the Advanced Course. This course, for professional personnel concerned in particular with occupational health problems, will be presented February 8–19, 1954. Further details and information may be obtained by writing: Chief, Radiological Health Training Section, Public Health Service, Environmental Health Center, Cincinnati, Ohio.

The **Philadelphia Physiological Society** announces a Symposium on Neuro-Humoral Mechanisms to be held Sept. 11 and 12, 1953 (following the International Congress of Physiology) in Medical Alumni Hall, University of Pennsylvania Hospital, 36th and Spruce Streets, Philadelphia, through the courtesy of a gift from Smith, Kline & French Laboratories. Principal speakers will be Otto Loewi, U. S. von Euler, H. Blaschko, C. Hebb, G. L. Brown, W. Paton, W. Feldberg, Sir Henry Dale, J. H. Burn, G. Liljestrand, R. W. Gerard.

Four **RCA Predoctoral Fellowships in Electronics** have been awarded by the National Research Council for special graduate training and experience in the general field of electronics, either as a branch of electrical engineering or as a part of the general field of physics. Award winners and the institutions at which they will study are: George S. Bahrs, Stanford; Charles W. Hoover, Jr., Yale; Gladwyn V. Lago, Purdue; and John B. Thomas, Stanford.

A branch charter of the **Scientific Research Society of America** has been granted to the Aluminum Company of America's Research Laboratories. T. Keith Glennan, President of Case Institute of Technology, addressed a gathering of Alcoa officials on the topic of the development of atomic power for industry. The meeting was held in honor of the granting of the charter on June 2 in Pittsburgh's University Club. Honored guests included Karl T. Compton and Edward R. Weidlein.

## Miscellaneous

Eight new members have been appointed to the **Agricultural Research Policy Committee** by Secretary of Agriculture Ezra Taft Benson. The Committee was formed to establish a national advisory group to be consulted on research and service work, and to assist in obtaining the cooperation of producers, farm organizations, industry groups, and Federal and State agencies.

New committee members are Roy Battles, assistant to the Master of the National Grange, Washington, D. C.; Frank Haumont, farmer and chairman of the Nebraska Farmers Union legislative committee, Broken Bow, Neb.; C. W. Kitchen, executive vice president of the United Fresh Fruit and Vegetable Association, Washington, D. C.; Charles R. Sayre, president and general manager of Delta and Pine Land Company, Scott, Miss.; Robert B. Taylor, wheat farmer, Adams, Ore; H. W. Vorhees, president, New Jersey Farm Bureau, Trenton, N. J.; Frank J. Welch, Dean of the College of Agriculture and Director of the Experiment Station and Extension Service, University of Kentucky, Lexington, Ky.; and Paul S. Willis, president, Grocery Manufacturers of America, Inc., New York, N. Y.

Incumbent members of the committee include H. L. Brinkley, executive vice president of the National Council of Farmer Cooperatives, Washington, D. C.; Anson A. Brock, director of California's State Department of Agriculture, Sacramento, Calif.; and Dr. Charles G. King, scientific director of the Nutrition Foundation and professor of chemistry at Columbia University, New York, N. Y.

The **Air Research and Development Command** has formed an Industry Advisory Committee on equipment cooling systems to assist the U. S. Air Force in overcoming the problem of extremely high temperatures encountered by supersonic aircraft and missiles. The committee will provide guidance to equipment specialists at Wright Air Development Center, Dayton, Ohio, on problems of requirements, developments, and installation of aircraft equipment cooling systems. The members are airframe manufacturer's employees and are specialists in the equipment cooling field. They recently spent six weeks at the Dayton Center reviewing problems and requirements of equipment from a cooling standpoint, and are preparing a report of their recommendations. Members of the committee are: Robert O'Clock, chairman, Equipment Laboratory, Wright Air Development Center; Ashley P. Adkins, Wright; Harry Dornbrand, Republic Aviation Corp.; Edward D. Mead, Jr., Glenn L. Martin Co.; Lloyd H. Gardner, Boeing Airplane Co.; Robert A. Paselk, North American Aviation; John L. Allen, Douglas Aircraft Co.; John W. Anderson, McDonnell Aircraft Corp.; John R. Emerson, Northrop Aircraft Inc.; Jack R. Woolf, Consolidated Vultee Aircraft Corp., Fort Worth Division; and Daniel Friedman, Naval Research Laboratory, who is providing liaison with the Navy on committee findings.

Thirty-one research projects will be put into the field this summer by the **Arctic Institute of North America.** The 1953 program, which will be carried out with support from the Office of Naval Research, will place investigators throughout the North American Arctic and Subarctic, from Little Diomede Island and Point Barrow in the west to Baffin Island and Greenland in the east. Studies will be conducted in linguistics, economics, geology, oceanography, entomology and others.

A complete list of the 1953 projects follows: Chester A. Arnold, Department of Botany, University of Michigan, paleobotanical investigations in northern Alaska; Patrick D. Baird, The Arctic Institute of North America, Montreal, Quebec, glaciological investigations of the Penny Highland Ice Cap, Baffin Island; Paul H. Baldwin, Department of Zoology, Colorado A. and M., the breeding, ecology, and physiological rhythms of some arctic birds at Umiat, Alaska; John Otis Brew, Director, Peabody Museum, Harvard University, an archaeological survey of Eskimo, or earlier, material in the vicinity of Point Barrow, Alaska; Lyman J. Chapman, Ontario Research Foundation, evapotranspiration studies in northern Canada; Frederick G. Cooch, Department of Conservation, Cornell University, continuation of a study of the Blue Goose, its life history, management and ecology; Frederica de Laguna, Chairman, Department of Sociology and Anthropology, Bryn Mawr College, continuation of combined ethnographical and archaeological investigations at Yakutat, Alaska; Philip Drucker, Bureau of American Ethnology,

Smithsonian Institution, modern inter-tribal organization in northern British Columbia and southern Alaska; Francis H. Fay, Department of Zoology, University of British Columbia, continuation of a study of the life history of the Pacific walrus; Karen J. Friedman, U. S. Department of Agriculture, current transition in Greenland's economy; Olaf Gjaerevoll, Curator of Botany, The Museum, Trondheim, Norway, a floristic and phytosociological investigation of the White Mountains, Alaska; Louis L. Hammerich, University of Copenhagen, a study of the Eskimos of southwestern Alaska, especially with respect to dialectic frontiers between the Eskimos and the Aleuts; Francis Harper, Mount Holly, New Jersey, a comprehensive investigation of the animal and plant resources of the Knob Lake Region, Labrador, Quebec; Ernest Lepage, Ecole d'Agriculture, Rimouski, Quebec, completion of an inventory of the flora of the west coast of James Bay, Ontario; John B. Lucke, Department of Geology, University of Connecticut, geologic investigation of the Shelikof Strait Area, Alaska; W. D. Mateer, Colorado School of Mines, ecology of the Arctic Foraminifera in the vicinity of Point Barrow, Alaska; William V. Mayer, Department of Zoology, University of Southern California, the life history of the Arctic ground squirrel (Citellus Parrui); John L. Mohr, Department of Zoology, University of Southern California, investigations of some aspects of the ecology of Arctic Crustaceans; David R. Moir, Department of Botany, North Dakota Agricultural College, continuation of a floristic survey of northwestern Ontario; David C. Nutt, Dartmouth College Museum, winter oceanographic studies of southern Labrador; Frank A. Pitelka, Museum of Vertebrate Zoology, University of California, population biology of Arctic land vertebrates; William Quaide, Museum of Paleontology, University of California, an inquiry into the paleontological and geological history of the Naval Petroleum Reserve #4 and adjoining areas; Edward S. Rogers, Department of Anthropology University of New Mexico, linguistic and ethnographic study of the Mistassini Indians of northern Quebec; Reese J. Sailer, U. S. National Museum, correlation of accumulated precipitation data with mosquito abundance in Alaska; Per Frederick Scholander, Woods Hole Oceanographic Institution, an investigation of osmotic pressures in the blood of Arctic and Subarctic marine fishes; Philip T. Spaulding, Department of Anthropology, University of Oregon, anthropological and linguistic investigations in the Aleutian Islands; Robert F. Spencer, Department of Anthropology, University of Minnesota, the human ecology of the Alaskan Arctic slope; William C. Steere, Stanford University, an investigation of the geographical distribution of mosses and liverworts (Bryophyta) in Arctic Alaska; George M. Sutton, Department of Zoology, University of Oklahoma, a comprehensive study of the birds of the Holarctic region; V. C. Wynne-Edwards, Department of Natural History, Aberdeen University, Aberdeen, Scotland, a study of the distribution and breeding biology of the sea-birds of southern Baffin Island.

Members of the Arctic Institute's Grants-in-Aid Committee, who serve in a personal capacity and not as representatives of the agencies with which they are affiliated, are: Alexander Wetmore, Chairman, The Smithsonian Institution, Washington, D. C.; Detlev W. Bronk, President, The Johns Hopkins University, Baltimore, Md.; C. H. D. Clark, Supervisor of Wildlife Management, Ontario Department of Lands and Forests, Toronto; M. J. Dunbar, Department of Zoology, McGill University, Montreal, Quebec; Paul A. Siple, Military Geographer, Office of Chief of Staff, U. S. Army, Washington, D. C.; O. M. Solandt, Chairman, Defense Research Board, Ottawa, Ontario; J. Tuzo Wilson, Professor of Geophysics, University of Toronto, Toronto, Ontario; J. K. Wright, American Geographical Society, New York, N. Y.

A continuation of the **Coral Atoll Research Program** sponsored by the Pacific Science Board of the National Academy of Sciences-National Research Council, with financial assistance from the Office of Naval Research, is now under way. Ifaluk, an atoll about 400 miles south of Guam in the Western Carolines, will be the site of field work which will parallel the pattern of ecological investigations that have been made of the atolls of Arno in the Marshalls, Onoton in the Gilberts, and Raroia in the Tuamotus. Results will be correllated with other atoll research, particularly work at Bikini, Eniwetok, and the current studies of the cooperative Pacific Geological Mapping Program. This program is also associated with an atoll project of the six-government South Pacific Commission concerned with problems affecting the economy of atoll peoples in Pacific areas administered by Australia, France, New Zealand, Netherlands, United Kingdom, and the United States. In 1948, E. G. Burrows and M. E. Spiro spent several months there under a Pacific Science Board Project supported by the Office of Naval Research as part of a Coordinated Investigation of Micronesian Anthropology.

Dr. Burrows, Professor of Anthropology at the University of Connecticut, will return to Ifaluk as leader of this summer's team. Other members include Marston Bates, University of Michigan, land fauna and flora; Donald P. Abbott, Stanford University, marine biology; J. I. Tracey, Jr., U. S. Geological Survey, geology; Theodore Arnow, U. S. Geological Survey, hydrology; F. M. Bayer, U. S. National Museum, marine invertebrates and algae; and Robert R. Harry, Academy of Natural Sciences, Philadelphia, ichthyology.

Four members of the staff of the **National Research Council of Canada** have been honored by the Royal Society of Canada. E. W. R. Steacie, President of the NRC, has been chosen vice-president of the Royal Society; J. T. Henderson, NRC Division of Physics, has been made Honorary Treasurer; and Gordon A. Adams, NRC Division of Applied Biology, and Harold J. Bernstein, NRC Division of Pure Chemistry, have been made Fellows.

**"The New Synthetic Fibers: A Symposium,"** which was presented at the Annual Meeting of the **AAAS** in St. Louis on Dec. 27, 1952, appears in the May, 1953, issue of the *Textile Research Journal* (Vol. XXXIII, No. 5). Papers by Frank J. Soday, Joseph B. Quig, J. R. Whinfield, H. F. Mark, and John H. Dillon make up the Symposium. The issue also includes a review of textile research and development during 1952, edited by Richard Steele, Corneil Messler, and J. H. Wakelin.

For the first time, **Westinghouse Electric Corporation** has offered summer employment to winners of the 1953 Science Talent Search. Ten teen-age scientists will work in such fields as physics, chemistry, metallurgy, and electronics, and some of them will work side by side with men and women who have major roles in the development and construction of the atomic power plant for the submarine U.S.S. *Nautilus*.

# Technical Papers

## Susceptibility of the Starch in Fresh and Stale Bread to Enzymatic Digestion

S. S. Jackel, A. S. Schultz, and W. E. Schaeder[1]

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It was reported recently (*1*) that the incorporation of low levels of bacterial α-amylase[2] in bread formulation resulted in baked products normal in all respects but characterized by greatly reduced rates of staling. In this connection it was demonstrated by measurement of the susceptibility of the bread starch to hydrolysis by β-amylase (*3*) that the starch changes generally considered to be of major causative importance in bread staling (*4–6*) were absent or significantly reduced in the products baked with the enzyme.

During the course of studies concerned with the nature of the starch changes accompanying the staling of bread, data were obtained which indicate that the rate of *in vitro* digestibility of stale bread by pancreatin is significantly less than that of fresh bread. Bread baked with bacterial α-amylase maintained an essentially constant rate of digestibility, equivalent to that of fresh bread, throughout the storage period.

These data, which are shown in Table 1, were obtained by a modification of the yeast fermentation method (*3*) involving substitution of pancreatin for α-amylase and buffering at pH 7.5 instead of at pH 5.2. In this method the amount of gas evolved during the digestion period, after prior removal of the carbohydrates directly fermentable by yeast, is related stoichiometrically to the amount of fermentable carbohydrate produced by the enzyme action.

TABLE 1

EFFECT OF AGE OF BREAD ON DIGESTION OF BREAD CRUMB BY PANCREATIN*

| Storage at 30° C (hr) | Gas production in fermentation test (ml) | | Rate of digestion† | |
|---|---|---|---|---|
| | Control bread | Bacterial α-amylase bread | Control bread | Bacterial α-amylase bread |
| 20 | 575 | 587 | 1.00 | 1.02 |
| 40 | 518 | 558 | 0.90 | 0.97 |
| 60 | 488 | 562 | .85 | .98 |
| 80 | 472 | 560 | .82 | .97 |
| 100 | 460 | 565 | .80 | .98 |
| 120 | 443 | 560 | .77 | .97 |
| 140 | 432 | 570 | .75 | .99 |
| 160 | 413 | 563 | .72 | .98 |

* Three-hour digestions carried out at 30° C on 20 g of bread crumb suspended in 100 ml of water containing 10 ml of McIlvaine's citric-phosphate buffer, pH 7.5. Digestion by 35 mg of pancreatin.

† Rates calculated relative to that of the bread stored at 30° C for 20 hr.

As shown in Table 1, the rate of digestion of the control bread decreased progressively during the 160-hr storage period to a value approximately 75% of that when the bread was reasonably fresh (20 hr old, stored at 30° C). The breads baked with 6 SKB units of bacterial α-amylase, on the other hand, maintained a digestibility rate essentially equivalent to that of the fresh control bread throughout the entire storage period.

It would appear from these data that stale bread is less readily digested under *in vitro* conditions than fresh bread and that inclusion of bacterial α-amylase in the bread formulation prevents the decrease in rate of digestion. Evaluation of the significance of these *in vitro* findings in terms of human nutrition will not be possible until suitable *in vivo* studies are carried out. Appropriate techniques, used in studies on the digestion of bread in the human stomach, have been published (*7*).

It is necessary to reconcile these results, indicating that the starch in fresh bread is more readily digested, with other *in vitro* reports (*8–10*) that oven-fresh bread is attacked with difficulty by proteolytic and diastatic enzymes. Although the conclusions appear contrary, there is reason to believe that the difference refers, not to inherent susceptibility of the starch substrate to enzymatic action, but rather to overall availability of the bread sample to enzymic attack. Oven-fresh bread does not disperse so easily or so well as bread even a few hours older. All samples in our experiments were thoroughly dispersed by mechanical means in order to permit conclusions referring specifically to susceptibility of the starch component to enzymatic digestion. The samples in the studies reported in the literature were not well dispersed and, presumably, the data obtained reflect differences in dispersibility of the samples on aging. In any event, the particular problem of oven-fresh bread is a special one with only narrow implications since commercial bread is generally not less than 8–12 hr old when it reaches the consumer.

From studies with humans (*11*) and laboratory animals (*12*) it appears well established that the total utilization of the carbohydrates in bread is essentially quantitative regardless of the age of the bread. In view of the known retrogradation of starch during bread staling, representing a polymerization and return towards the non-gelatinized state, it appeared of value to establish whether a similar conclusion would be drawn under *in vitro* conditions. The same technique used to obtain the other data of this paper was

[1] We are indebted to F. D. Schoonover for baking the breads used in this study.

[2] The α-amylase (*B. subtilis* type) was added at the rate of 3–6 Sandstedt, Kneen- and Blish units (*2*) per pound of bread.

followed, except that the amount of panereatin was increased to 500 mg to provide a rapid rate of hydrolysis. From 20 g of interior bread crumb, 1220 ml of gas (±2%) were obtained regardless of the age of the bread (up to 1 week at 30° C). Thus, the *in vitro* data are in agreement with *in vivo* data (*11, 12*) indicating that the extent of digestion of the starch in bread is not influenced by the age of the bread.

Further studies are underway concerned with the nature of the changes in the starch component accompanying the staling of bread, and with the nature of the mechanism involved in the favorable action of bacterial α-amylase in preventing or retarding these changes.

### References


1. Schultz, A. S., *et al. Cereal Chem.*, **29**, 200 (1952).
2. Sandstedt, R. M., Kneen, E., and Blish, M. J. *Ibid.* **16**, 712 (1939).
3. Jackel, S. S., *et al. Ibid.*, **29**, 190 (1952).
4. Geddes, W. F., and Bice, C. W. *Q.M.C. 17–10*. War Department. Office of the Quartermaster General, Washington, D. C. (1946).
5. Kerr, R. W. *Chemistry and Industry of Starch*, 2nd ed. New York: Academic Press (1950).
6. Whistler, R. L. *Purdue Univ. Agr. Expt. Sta. Rept.* File No. C-205 (1947).
7. Rostorfer, H. H., Kochakian, C. D., and Murlin, J. R. *J. Nutrition*, **26**, 123 (1943).
8. Bartels, L. *Mehl u. Brot.*, **42**, 21, 41 (1943).
9. Habs, H., and Plagemann, L. *Deut. Z. Verdauungs-u. Stoffwechselkrankh.*, **7**, 129 (1943).
10. Heupke, W. *Münch. med. Wochschr.*, **89**, 128 (1942).
11. Habs, H. *Deut. Z. Verdauungs-u. Stoffwechselkrankh.*, **7**, 201 (1943).
12. Abelin, I., and Biderbost, A. *Biochem. Z.*, **247**, 429 (1932).


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## A Simple Method for Making Transfers in Paper Chromatography


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A very efficient technique for elution of water-soluble compounds from paper chromatograms is that described by Wyatt (*1*). In this procedure the strip of paper to be extracted, cut to a point at one end, is developed as a descending chromatogram with water which is allowed to drip from the pointed end of the strip into a receiver. Compounds which travel with the front may be eluted in a few drops of water. We have been using a modification of this technique to transfer single components to another chromatographic strip for development with a different solvent. Transfer of the eluate in the ordinary way, after evaporation, is complicated by the requirement of keeping the size of the initial spot on the new chromatogram as small as possible. This necessitates performing the transfer in portions of a few microliters at a time and letting each portion dry before the next is applied. As numerous washings are required, this procedure may be very time-consuming.

It has been found possible to perform the entire transfer as a continuous process by using the arrangement shown in Fig. 1. The strip of filter paper to which the transfer is to be made is sandwiched between 2 sheets of glass or plastic in which are matching round holes about 1¼ in. in diameter. The elution is performed in a small chamber resting upon these sheets so that the air in the elution chamber can be kept nearly saturated with water vapor—an essential condition if the elution is to proceed properly. The original strip is suspended from the developing trough so that its pointed tip just touches the new strip in the center of the round window. When the water front reaches this point and begins to spread on the new strip, a stream of air at room temperature, directed aganist the under side of the paper window, is sufficient to evaporate the eluate as rapidly as it flows. In this way, the spot size may be kept as small as is desired by regulating the air flow, and the time required for the transfer is just the time required for the elution.

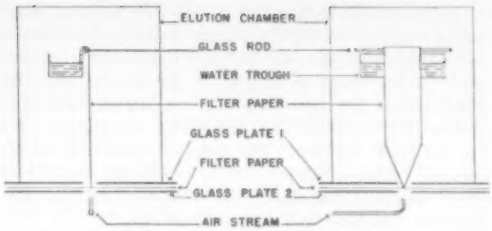


Fig. 1. Sketch of apparatus used for single stage transfer between chromatographic runs.

Since the water flow is not observable under these conditions, the time necessary to complete the elution must be determined indirectly. The method we find most convenient is as follows. A 10-cm length of the strip (*A*) to be eluted is marked off in 0.5-cm divisions with lead pencil. The elution is then begun. When the water front reaches the tip of strip *A* and begins to spread on the new strip (*B*) a colored compound of known $R_f$ value is applied at the graduation farthest from the tip of *A*. The subsequent travel of such a marker is linear with time during the evaporation. The $R_f$ of the marker and the distance it has moved being known, together with the water-loading and the width of strip *A*, the volume of water which has been evaporated at any time may be calculated. If its $R_f$ is sufficiently small, the indicator itself will not be eluted in the time it takes to evaporate the required 0.5 ml of water. The water-loading is determined by weighing strips of known area under similar conditions. We find about 12 mg of water/cm² in a wet strip of Whatman No. 1 paper during an elution.

As a marker an orange-colored indelible pencil (Mongol No. 962, Eberhard Faber Co.) is very convenient, since it may be inserted through a small hole in the lid of the elution chamber without altering the water saturation of the enclosed air, and the $R_f$ of the orange dye has a suitable value—about 0.52 in our experiments.

An intermediate transfer in this way between chromatographic runs with different solvents has certain advantages over two-dimensional paper chromatography. In the usual technique, at the end of the first development the spots have increased in size and they become still more diffuse during the second run. By the transfer technique the original spot size is recovered. Also, separate treatment of the individual spots makes it feasible to use different solvents for different components in the second run.


**Reference**

1. WYATT, G. R. *Biochem. J.*, **48**, 581 (1951).



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## Comparative Effects of Total Body and Tail Heating on the Peripheral Leukocyte Count of the Rat[1]


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A reduction in the peripheral lymphocyte count has been widely employed as an index of adrenocortical activation in the rat. It is becoming increasingly apparent, however, that a number of factors other than the amount of circulating corticoids may alter the peripheral lymphocyte count and hence may affect the validity of this measurement as an index of adrenocortical activity. Marked variations have been reported as to what constitutes a "normal" leukocyte count in the peripheral blood of the rat (*1–6*). Such factors as whether the blood specimen was taken from an anesthetized or unanesthetized rat, the type of anesthetic employed, varying techniques in restraining the animal and in obtaining the blood specimen, all may affect the peripheral leukocyte count. Data are presented on the comparative effects of total body versus localized tail heating (when employed as experimental procedures in obtaining the blood specimen) on the peripheral leukocyte count of the rat.

The animals employed in the experiment were female rats of the Long-Evans strain. Animals were placed at weaning on the following diets, and blood counts were taken when rats had attained the weights indicated in Table 1. Two experimental rations were employed: diet A and diet B. Diet A was a natural food ration;[2] diet B was a purified ration of the following composition: sucrose, 61%; casein,[3] 24%; salt mixture,[4] 5%; cottonseed oil (Wesson), 8%; and wheat-germ oil (Vio Bin), 2%. To each kg of the above diet were added the following synthetic vitamins: thiamine hydrochloride, 10 mg; riboflavin, 10 mg; pyridoxine hydrochloride, 10 mg; nicotinic acid, 60 mg; calcium pantothenate, 60 mg; biotin, 5 mg; 2-methylnaphthoquinone, 5 mg; folic acid, 10 mg; ascorbic acid, 100 mg; *p*-aminobenzoic acid, 400 mg; inositol, 800 mg; vitamin $B_{12}$, 100 μg; and choline chloride, 2 g. To each kg of diet were also added 6000 USP units of vitamin A[5] and 600 USP units of vitamin D[6]. The vitamins were added in place of an equal amount of sucrose.

When taking the blood specimens, animals were divided into 2 groups. Half the animals had blood specimens taken following localized tail heating; the remainder after total body heating. The procedures differed as follows: in the localized tail-heating group, unanesthetized rats were wrapped in a towel with only the tail protruding. Free-flowing blood was collected from the tail after warming it in hot water and snipping a bit from the end with scissors or scalpel. Total body heating was administered by placing rats in small metal cages with screen sides and bottom, before an electric heater for a period of 20–30 min. The procedures employed in taking the blood specimens in

TABLE 1

COMPARATIVE EFFECTS OF TOTAL BODY HEATING AND TAIL HEATING ON THE PERIPHERAL BLOOD COUNT OF THE RAT

| Group | Number of animals | Body wt. (g) | RBC | | Total WBC | | Lymphocytes | Granulocytes | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Av. | Range (in millions) | Av. | Range | | % | Total |
| Diet A | | | | | | | | | |
| Tail heating | 12 | 113 | 7.5 | (7.0–8.1) | 9,740 | (7,750–13,600) | 7,987 | 18 | 1,753 |
| Total body heating | 12 | 107 | 6.9 | (6.1–7.9) | 5,462 | (2,700– 8,250) | 3,933 | 28 | 1,529 |
| Diet B | | | | | | | | | |
| Tail heating | 20 | 166 | 7.4 | (6.9–8.1) | 10,266 | (8,150–14,400) | 8,315 | 19 | 1,951 |
| Total body heating | 20 | 164 | 7.3 | (7.0–8.1) | 6,143 | (3,150– 8,200) | 4,546 | 26 | 1,597 |
| Diet B | | | | | | | | | |
| Tail heating | 8 | 114 | 6.6 | (6.0–7.1) | 10,112 | (8,900–11,300) | 8,191 | 19 | 1,921 |
| Total body heating | 8 | 114 | 5.9 | (5.3–6.7) | 4,625 | (4,200– 6,000) | 3,654 | 21 | 971 |

Data for RBC, total WBC, total granulocytes, and lymphocytes are expressed as cells/mm³.


[1] This study was supported in part by the Office of Naval Research.


[2] Purina Laboratory Chow, Ralston Purina Co., St. Louis, Mo., supplemented twice weekly with lettuce.

[3] Vitamin-Free Test Casein, General Biochemicals, Chagrin Falls, Ohio.

[4] Hubbel, Mendel and Wakeman Salt Mixture, General Biochemicals, Chagrin Falls, Ohio.

[5] Myva-Dry Powder, Distillation Products, Rochester, N. Y.

[6] Hy-Dee Powder, Standard Brands, New York, N. Y.

this group were the same as in the first series, except that localized tail heating was omitted. Erythrocyte and leukocyte counts were made with the usual pipets and diluting fluids; differential counts were made on smears stained with Wright's stain, 100 cells on each of 2 slides being employed for each analysis. Results are summarized in Table 1.

A significant difference was observed in the total WBC and lymphocyte count of the peripheral blood of rats, when blood specimens were taken following total body heating, as distinct from localized tail heating. In the latter group, the data for total WBC and lymphocytes in peripheral blood were comparable to those reported by other investigators for the rat (*2*); animals subjected to total body heating, however, had a significant reduction in the total WBC and lymphocyte count. The reduction was apparently not due to hemodilution, since little, if any, decrease occurred in the erythrocyte count. A reduction was also noted in the number of granulocytes per cubic mm of peripheral blood following total body heating. This decrease, however, was less marked than the reduction in lymphocyte count. Similar findings were obtained on both experimental rations. Determinations were also made of the leukocyte count of peripheral blood after localized tail heating and 20 min later on the same animals after total body heating. A reduction in the peripheral leukocyte count after total body heating was observed in these animals of the same order of magnitude as that reported above.

It has been established that the white cell count of peripheral blood is significantly greater than that of heart blood (*5–8*). This condition is caused, according to Quimby and Goff (*6*), by the "damming up" of white cells in the peripheral areas of the vascular system as a result of the normal resistance of the arterioles and capillaries to the flow of the blood. When rats were anesthetized with ether, the difference in white cell count between heart and peripheral blood was abolished, presumably because "ether and other substances which relax the contractile elements of the blood vessels and increase their lumen diameter reduce the resistance offered by the peripheral vascular bed to the flow of blood cells and result in a more even distribution of the leukocytes between the large and small vessels" (*6*). In the present experiment, total body heating similarly resulted in a significant reduction in the leukocyte count of peripheral blood to values comparable to that of heart blood (*5–6*). It would seem likely that an increase in circulation rate and small vessel dilatation (*9–11*) resulting from total body heating were responsible, at least in part, for the observed effects.

Total body heating has the following advantages over tail heating as an experimental procedure for obtaining blood specimens in the rat: (1) less handling of the animal is required in this procedure, since localized warming of the tail is omitted, and as a result, blood specimens may be obtained more quickly (once the animal is wrapped in the towel) with a minimum of restraint to the animal; (2) alterations in the blood count due to the stressor effects of warming the tail in hot water and the longer period of restraint in animals subjected to localized tail heating are minimized when total body heating is employed (this advantage would be particularly marked when multiple counts are made over an extended period of time); (3) the flow of blood on severing the tip of the tail, after total body heating, is more profuse than that generally obtained after localized tail heating. Total body heating would appear to have particular value, therefore, in obtaining blood specimens from nutritionally deficient or "toxic" animals from whom adequate amounts of free-flowing tail blood are difficult to obtain following localized tail heating.

### References


1. Donaldson, H. H. *The Rat.* Memoirs of the Wistar Institute, Philadelphia (1924).
2. Scarborough, R. A. *Yale J. Biol. & Med.*, **3**, 267 (1931).
3. Jordan, H. E. *Handbook of Hematology.* Vol. II, 763. H. Downey, Editor. New York: Hoeber (1938).
4. Creskoff, A. J., Fitzhugh, T., and Farris, E. J. In: Griffith and Farris: *The Rat in Laboratory Investigation*, 351. Philadelphia (1942).
5. Quimby, F. H., Saxon, P. A., and Goff, L. G. *Science*, **107**, 447 (1948).
6. Quimby, F. H., and Goff, L. G. *Am. J. Physiol.*, **170**, 196 (1952).
7. Klieneberger, C., and Carl, W. *Die Blut-Morphologie der Laboratoriums-Tiere.* Leipzig: Barth (1912).
8. Roofe, P. G., Latimer, H. B., Madison, M., Maffet, M., and Wilkinson, P. *Science*, **111**, 337 (1950).
9. Goodman, L., and Gilman, A. *The Pharmacological Basis of Therapeutics*, 67. New York: Macmillan (1941).
10. Mann, F. C., Essex, H. E., Herrick, J. F., and Balder, E. J. *West. J. Surg.*, **43**, 177 (1935).
11. Foregger, R. *Anesthesiology*, **4**, 392 (1943).


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## Estrogen Excretion in Women with Mammary Cancer before and after Adrenalectomy[1]


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This paper presents data on the excretion of estrogen in the urine of women with cancer of the breast, before and after both adrenal glands were excised. Estrogens are known to be importantly involved in the genesis of mammary neoplasms in mice (*1*). It is known (*2*) that ovariectomy sometimes causes a remission of this disease in women. It has been further established that bilateral adrenalectomy (*3*), with maintenance on cortisone acetate, causes a significant regression of mammary cancer in ovariectomized women in certain cases.

It has been shown (*4*) that estrogen is produced in the adrenals of certain strains of mice in which the gonads were excised in early life. Also, estrone has

[1] This investigation was supported by grants from the American Cancer Society, upon recommendation of the Committee on Growth of the National Research Council and from the Jane Coffin Childs Memorial Fund for Medical Research.

TABLE 1

ESTROGEN EXCRETION IN URINE OF HUMAN FEMALES
I.U./24 hr.

| Groups* | Number | Age (years) | Range (I.U.) | Mean (I.U.) |
|---|---|---|---|---|
| 1. Normal, premenopausal | 8 | 21–41 | 13.8–55.6 | 33.0 |
| 2. Normal, postmenopausal | 4 | 45–77 | 0.3– 9.1 | 4.7 |
| 3. Cancer, premenopausal | 4 | 38–51 | 13.4–53.8 | 28.2 |
| 4. Cancer, x-ray castration | 6 | 43–58 | 4.7–20.1 | 14.7 |
| 5. Cancer, surgical ovariectomy | 6 | 38–57 | 0 –38.1 | 16.6 |
| 6. Cancer, ovariectomy and adrenalectomy | 12 | 38–58 | 0 | 0 |

* Groups 3–6, widespread mammary cancer.

been extracted from adrenal gland concentrates (*5*). It is known that in the human male (*6, 7*), adrenal neoplasms which produce feminization cause a slightly increased excretion of estrogen.

Estrogen assays were performed on multiple collections of urine, each of 24 hr, from 12 women with breast cancer, and from 12 normal noncancerous women as controls. Estrogen was extracted from the urine after acid hydrolysis by a slight modification of the method of Pincus and Pearlman (*8*). Quantitative determinations of estrogen in the extracts were made by bioassay using the uterine weight method of Evans, Varney, and Koch (*9*).

Thus, confirming previous studies (*8, 10, 11*), the urinary excretion of estrogen in premenopausal women was in the same range regardless of the presence or absence of breast cancer. Elimination of ovarian function by roentgen irradiation or ovariectomy led to similar lowered values of estrogen excreted in urine; the amount was reduced by one-half (Table 1). When adrenalectomy was performed after elimination of ovarian function, estrogen was no longer detectable in the urine. Nine of 12 patients with mammary cancer subjected to adrenalectomy in this series, showed an actual measurable decrease in the extent of neoplastic involvement after the operation. This regression was observed in one or more of the following areas: local recurrent carcinoma, osseous metastases, pleural involvement.

The results show: first, patients with breast cancer who had had eradication of ovarian function by irradiation or surgical excision, still excreted estrogen in significant amount; secondly, adrenalectomy eliminates estrogen from the urine of those cases. It is evident that the adrenals are the only significant source of estrogen in women with breast cancer who do not have active ovarian function.

The 3 patients with mammary cancer who did not have a regression of the neoplasm after adrenalectomy, excreted 9.6, 12.3, and 20.1 I.U. *per diem* preoperatively. Two of these values are below the mean titer for ovariectomized women (Table 1). It is impossible, however, to state from this study that the reduction of estrogen was the critical factor in the remission of the disease.


**References**

1. LACASSAGNE, A. *Compt. rend.*, **195**, 630 (1932).
2. BEATSON, G. T. *Lancet*, **2**, 104, 162 (1896).
3. HUGGINS, C., and BERGENSTAL, D. M. *Cancer Research*, **12**, 134 (1952).
4. WOOLEY, G., FEKETE, E., and LITTLE, C. C. *Proc. Natl. Acad. Sci. U. S.*, **25**, 277 (1939).
5. BEALL, D. *Nature*, **144**, 76 (1939).
6. WILKINS, L. *J. Clin. Endocrinol.*, **8**, 111 (1948).
7. HUGGINS, C., and BERGENSTAL, D. M. *J. Am. Med. Assoc.*, **147**, 101 (1951).
8. PINCUS, G., and PEARLMAN, W. H. *Cancer Research*, **1**, 970 (1941).
9. EVANS, J. S., VARNEY, R. F., and KOCH, F. C. *Endocrinology*, **28**, 747 (1941).
10. TAYLOR, H. C., MECKE, F. E., and TWOMBLY, G. H. *Cancer Research*, **3**, 180 (1943).
11. NATHANSON, I. T. *Cancer Research*, **3**, 132 (1943).



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## A Metal-Filled Microelectrode[1]


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Microelectrodes are finding a steadily increasing area of application in biological research. Glass microcapillaries filled with an electrolyte solution are in common use (*1–5*). Such electrodes record single-unit activity with a low signal-to-background ratio if their tips are large. Electrodes with small tips have a high impedance making necessary the use of a special high-input-impedance amplifier (*5*). The microelectrodes of Weale (*6*) and Svaetichin (*7*) are recent efforts to fill the need for an electrode of low impedance. The Svaetichin electrode is difficult to prepare, and we have been unable to make a satisfactory electrode following Weale's directions. A new low-impedance-microelectrode is described here in which a glass "wetting" metal is used to fill a glass microcapillary. This microelectrode is sturdier than saline-filled electrodes of comparable size, and it is relatively easy to prepare.

Gallium and indium[3] and many of their alloys possess the unusual property of "wetting" glass. An alloy of 50% In—50% Sn, m.p. 110° C, or pure indium, m.p. 156° C, is used in the preparation of the microelectrodes.

Precision drawn Pyrex capillary tubing, 0.8 mm O.D., 0.5–0.6 mm I.D., is thoroughly cleaned, dried, and cut into 4–5 in. lengths. The metal is melted on


[1] Aided by a contract between the Office of Naval Research, Department of the Navy, and the Johns Hopkins University (NR 113–241) and by a grant (B-17) from the Research Grants Division, National Institutes of Health, USPHS.



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[3] The gallium and indium used in this work were generously supplied by the Aluminum Corporation of America and the Indium Corporation of America respectively.

a hot plate or in an oil bath. Excessive heating will cause the formation of yellow oxides of indium. By means of gentle suction, metal is drawn up the glass capillary in a continuous column to about the midpoint and allowed to solidify (Fig. 1a). To prevent the contamination of capillaries, any scum which forms on the surface of the melt should be removed frequently.

At a point about 2 mm beyond the end of the metal column, the glass capillary is heated and drawn out into a micro-tip of the desired size and shape (Fig. 1b). The use of a Livingston micropipette puller (*8*) enables rapid preparation of large numbers of electrodes of uniform tip dimensions. After the tip has been drawn, the capillary is heated on a hot plate until the metal column just melts. Using a snugly fitting sewing needle inserted into the open end of the capillary as a piston, the metal column is gently pushed to fill the tip. Metal is extruded from the tip to form a tiny drop 30–50 μ in diameter. The electrode is cooled and the metal ball gently blown off. An undesirable cuff of metal may be formed on the outer surface of the glass if the metal ball is too large. The steel needle remains in place; its free end is used for electrical contact.

A layer of gold is electrodeposited on the tip of the microelectrode immediately after the filling operation. A gold cyanide solution (0.2% Au) is used for plating, with a 1.5 v dry cell in series with a 5–10 megohm resistor as a source of current. The microelectrode is connected to the negative pole. For an electrode with a 2–4 μ tip, the plating time is 30–45 sec. On the chemically inert and impervious gold base, platinum black is electrodeposited from a bath of 0.4% platinum chloride (Fig. 1c). The plating time and current are the same as those used for gold plating. The microelectrodes are examined under the microscope for defects at each stage in their preparation.

FIG. 1. Three stages in preparation of the microelectrode. (a) capillary tubing filled half-way with metal: (b) the capillary after the tip has been drawn and before the metal was pushed to fill it completely: (c) the end of the electrode filled with metal. Note the platinum-black deposit visible as a small ball. Magnification in (a) and (b) is indicated by the line representing 1 mm: magnification in (c) is shown by the line representing 10 μ. The shadows cast during photography make the walls of the capillary in (a) and (b) appear to be thicker than 0.2 mm.

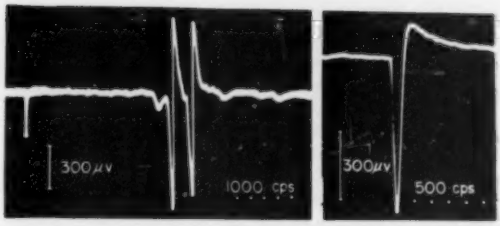


FIG. 2. Tracing on left: Single-unit discharge in the tactile region of the thalamus resulting from electrical stimulation of a small twig of a cutaneous nerve in the skin of the forearm. Cat. Nembutal anesthesia. Note that the unit discharges twice. The deflection on extreme left is the stimulus artefact. Tracing on right: Spontaneous potential recorded from fibrillating rat muscle. Anterior gracilis muscle denervated 12 days. Downward deflection is positive in both records.

The electrode conductivity is tested in the following manner. A platinum wire, insulated except for a 1-mm length near its midpoint, is connected across the output of a 1000-cycle oscillator. The wire, submerged in a tumbler full of physiological saline solution, acts as a source of current. A steel-needle-recording electrode is immersed in the saline bath a few cm from the current source and connected to an amplifier of 0.5 megohm input impedance. A grounded wire is submerged in the bath to complete the circuit. The signal amplitude is noted on a cathode-ray oscilloscope. The steel needle is now replaced by the microelectrode to be tested and the amplitude of the signal is compared with that previously recorded. Microelectrodes with excessively large exposed metal surfaces will record signals 80% or more as high as the control. Signals of 30–60% height are obtained from satisfactory electrodes of 2–4 μ tip diameter.

The electrodes described have been used by Mountcastle and Rose (*9*) to record potentials in the somatic-sensory group of nuclei in the thalamus. In this region, almost continual unitary activity initially negative in sign is recordable with electrodes of 2–4 μ. Usually, however, more than one such potential is recorded at the same time and the discharges tend to decrease in amplitude with time. Occasionally, a potential representing activity of a single unit, initially positive, is recorded within the nuclear region (Fig. 2). The discharge is, as a rule, recorded in complete isolation, and it often tends to persist underneath the electrode for several hours without much change. In the tactile thalamic region several initially positive unitary po-

tentials can be often isolated in succession over a distance of 1–2 mm.

These electrodes have also been used to study action potentials in rat muscle *in situ* (*10*). In normal muscle at rest, no electrical activity was detected. In chronically denervated muscle, shown by conventional electrodes to be fibrillating, spontaneous potentials were recorded. Most commonly these were diphasic spikes (Fig. 2), the large initial deflection being positive, and they recurred in totally irregular rhythm at a rate averaging about 6/sec.


**References**

1. Ettisch, G., and Peterfi, T. *Pflügers. Arch. ges. Physiol.*, **208**, 454, 467 (1925).
2. Taylor, C. V. *Proc. Soc. Exptl. Biol. Med.*, **23**, 147 (1925).
3. Gelfan, S. *Ibid.*, 308.
4. Renshaw, B., Forbes, A., and Morison, B. R. *J. Neurophysiol.*, **3**, 74 (1940).
5. Ling, G., and Gerard, R. W. *J. Cellular Comp. Physiol.*, **34**, 383 (1949).
6. Weale, R. A. *Nature*, **167**, 529 (1951).
7. Svaetichin, G. *Acta Physiol. Scand.*, **24**, Supl. 86, 5 (1951).
8. Livingston, L. G. Swarthmore College. Unpublished.
9. Mountcastle, V. B., and Rose, J. E. *Federation Proc.*, **11**, 109 (1952).
10. Jarcho, L. W., Dowben, R. M., and Lilienthal, J. L., Jr. In preparation.



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## Modification of the Distribution and Excretion of Radioisotopes by Chelating Agents[1]


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When the sodium salt and calcium chelate of ethylenediamine tetraacetic acid (EDTA) are administered intravenously to man, an equivalent amount of calcium is rapidly excreted by the kidneys (*1, 2*). Lead-EDTA and yttrium EDTA have been demonstrated to leave the body quite rapidly when injected intravenously (*3, 4*). Furthermore, when carbon$^{14}$-labeled EDTA is injected into animals, 99% is excreted in 48 hr (*5*). It was, therefore, rather unexpected to find in the course of our work on the distribution and excretion of lanthanum (*6*) in man, that less than 10% of the lanthanum is excreted through the kidneys when lanthanum-EDTA is intravenously administered, and it was decided to investigate this effect further.

A tracer dose of 200 μc lanthanum$^{140}$ as the EDTA complex was injected intravenously. The patient was catheterized to facilitate accurate urine collections. Urine and blood samples were collected at frequent intervals until the activity was no longer measurable. After 48 hr, the urinary excretion of lanthanum$^{140}$ had become negligible. However, only about 5% of the injected lanthanum$^{140}$ dose had been excreted up to that time, as indicated in the lower curve of Fig. 1.


[1] This study has been supported by a Contract AT(30-1)-880 with the United States Atomic Energy Commission.


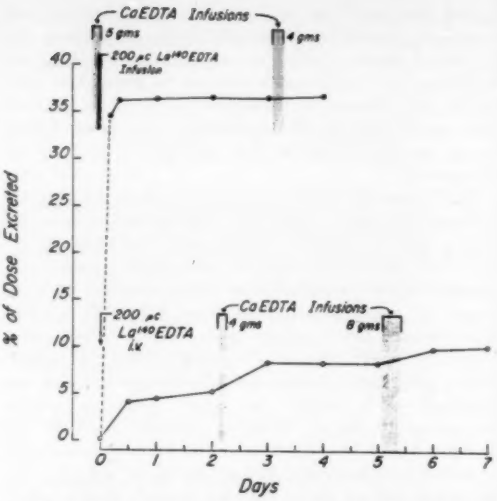


FIG. 1. Effect of calcium-EDTA upon the cumulative urinary excretion of lanthanum$^{140}$-EDTA. The upper graph illustrates the effect of preceding and *simultaneous* administration, and the lower graph that of *subsequent* infusions of calcium-EDTA.

At this time, 4 g of calcium-EDTA in 500 ml of a 5% solution of glucose in water were infused in 3 hr. Immediately after the start of the infusion, the rate of urinary excretion of the lanthanum$^{140}$ rose by a factor of approximately 100, as shown in Fig. 2. By the 5th day, urinary excretion had again become negligible, and a 7-hr infusion of 8 g of calcium-EDTA in 1000

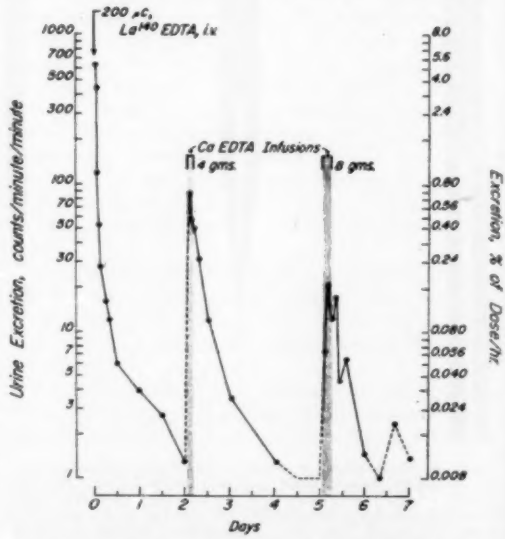


FIG. 2. Influence of calcium-EDTA upon the rate of urinary excretion of lanthanum$^{140}$-EDTA, expressed in terms of measured radioactivity and of the proportion of the total dose excreted per hour.

ml glucose solution was given. As Fig. 2 shows, the urinary excretion of lanthanum$^{140}$ rose rapidly once more. The short half-life of lanthanum$^{140}$ (40.4 hr) resulted in low counting rates and large statistical errors so that the irregular shape of the excretion curve after the last infusion has no true significance.

When lanthanum$^{140}$ was injected as the chloride instead of the EDTA, less than 5% of the injected dose was excreted through the kidneys over a period of 48 hr. However, subsequent calcium-EDTA infusions were equally effective in enhancing urinary excretion of lanthanum$^{140}$.

Although the response to calcium-EDTA infusions in promoting lanthanum$^{140}$ excretion is quite definite, the *total* amount of lanthanum$^{140}$ excreted is only of the order of 10–15%. It was found that shortening the time interval between injection of lanthanum$^{140}$ as lanthanum-EDTA or lanthanum chloride and the subsequent infusion of calcium-EDTA increased the total lanthanum$^{140}$ urinary excretion. In an effort to further enhance lanthanum excretion, calcium-EDTA was administered *simultaneously* with, and in part, even prior to the lanthanum$^{140}$ EDTA infusion.

A "priming" dose of 3 g of calcium-EDTA in 300 ml glucose solution was infused in 2.5 hr and was followed by a 1.5-hr infusion containing 2 g of calcium-EDTA and 200 μc lanthanum$^{140}$-EDTA. The immediate urinary excretion of lanthanum$^{140}$ was found to be rapid. Approximately 37% of the total activity was eliminated in the first day, about 30% being excreted in the first 4 hr as may be seen in the upper curve of Fig. 1.

These results are in qualitative agreement with decontamination studies using iron$^{59}$ and yttrium$^{91}$ (*7, 8*). From the above results, as well as from current distribution studies in animals using lanthanum-EDTA and lanthanum chloride, it seems that the lanthanum in the lanthanum-EDTA complex can be replaced in significant amounts by physiological competitors such as calcium. Experiments with calcium$^{45}$ as a tracer indicate that the calcium bound to EDTA is capable of prompt exchange with the calcium depots of the body (*2*). Therefore, it seems reasonable to assume that calcium exchanges also with lanthanum$^{140}$. The somewhat stronger bond formed by lanthanum with EDTA at physiological pH values does not rule out the possibility of calcium exchange by virtue of the law of mass action. Such an effect has not been reported for the lead-EDTA and yttrium-EDTA complexes, probably because of the greater affinity of these metals for the chelating agent.

The renewed excretion of lanthanum$^{140}$ following the infusion of calcium-EDTA may be explained by the exchange of lanthanum$^{140}$ for calcium; lanthanum which has been deposited in the bones and other tissues may thus once again form lanthanum-EDTA and be excreted. The equal effectiveness of calcium-EDTA infusions in promoting excretion of lanthanum following lanthanum chloride as well as lanthanum-EDTA injections would seem to support this hypothesis. When large amounts of calcium-EDTA and tracer amounts of lanthanum-EDTA are infused simultaneously, the increased amount of EDTA available for combination with lanthanum reduces the possibility of lanthanum remaining in ionic form and consequently the kidneys excrete more lanthanum in form of lanthanum-EDTA. Yet, even under these conditions, only 40% of the lanthanum is excreted and it would appear that, in addition, some irreversible binding or absorption of lanthanum occurs in the organism.

The fact that the effectiveness of lanthanum-removal by this chelating agent (EDTA) decreases with time, suggests its use as an investigative tool. Metals with different chelating tendency and affinities to body constituents (extra- or intracellular) will be removable in varying quantities, depending upon the specific properties, relative strengths, amounts, and time of administration of the complexing agents employed. That is, a given chelating agent will be effective only until the metal becomes physically or chemically unavailable. Furthermore, the prompt removal by chelating agents of excess radioisotopes subsequent to their administration in therapeutic doses suggests itself as a general method of changing the relative distribution, radiation efficiency and biological half-life of such isotopes. The use of chelating agents may thus permit the administration of isotopes of longer "physical" half-life to humans than has previously been considered safe.

### References


1. Spencer, H., *et al. J. Clin. Invest.*, **31**, 1023 (1952).
2. Bellin, J., and Laszlo, D. *Science*, **117**, 331 (1953).
3. Rubin, M., Gignac, S., and Popovici, A. *Abstracts, Spring Meeting, American Chemical Society*. Milwaukee, Wisconsin, April, 1952.
4. Foreman, H. Decontamination studies. *Report of University of California Radiation Laboratory*, 683, 38 (1952).
5. Foreman, H. Personal communication.
6. Laszlo, D., *et al. J. Natl. Cancer Inst.*, **13**, 559 (1952).
7. Foreman, H., *et al. Proc. Soc. Exptl. Biol. Med.*, **79**, 520 (1952).
8. Cohn, S. H., Gong, J. K., and Fisher, M. C. *Nucleonics*, **11**, 56 (1953).


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## Colloidal-Size Silica in Sediments


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For many years students of sedimentation have questioned the role of colloidal silica in sediments. Most workers believe that dissolved silica is transported and precipitated in colloidal form. Very little is known about the amount of silica which is precipitated as a colloid. A recent study by Roy (*1*) indicates that silica in natural waters is in true solution, probably as an $SiO_3^{2-}$ ion. In light of this study by Roy, the problem of chemical silica in sediments should be re-evaluated.

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The term chemical silica as used in this discussion means silica which is precipitated. The objectives of this paper are to show that chemical silica is present in large quantities in recent marine sediments and that many ancient clays and shales contain chemically precipitated colloidal-size quartz.

Chemical analyses of river and sea water and recent marine and ancient sediments are cited in many sources of geological literature. X-ray diffraction and differential thermal analysis techniques have led to some excellent mineralogical analyses of the colloidal fractions of recent marine sediments and ancient shales and clays. An analysis of these data is significant in evaluating the role of chemical silica in sediments. If silica has been and is being precipitated as a colloid and recrystallized as colloidal-size quartz, there should be colloidal-size quartz in recent marine sediments and inancient clays and shales. These sediments do contain appreciable quantities of colloidal-size quartz, as will be shown in this discussion.

*Silica in river water and sea water.* The concentration of silica in fluviatile waters has been reported by Clarke (*2*). He gave the following averages of the percentage of silica of dissolved solids in the fluviatile waters of the major continents:

| | |
|---|---|
| Waters of North America | 8.60 |
| Waters of South America | 18.88 |
| Waters of Europe | 8.70 |
| Waters of Asia | 9.51 |
| Waters of Africa | 17.89 |
| General average | 11.67 |

The concentration of silica in the dissolved solids in the river waters of South America and Africa is relatively high compared with the other continents. The tropical climate and weathering conditions are probably the major causes of the high concentration since these factors increase the effectiveness of removing the silica from the drainage areas. The silica content of the dissolved solids in the waters of the other continents is large, and only Ca, $CO_3$, and $SO_4$ are present in larger quantities. Clarke (*2*) estimated that 319, $170 \times 10^3$ tons of $SiO_2$ are added to the oceans annually from river waters.

The concentration of silica in the dissolved solids in ocean waters is much less than that which is present in the dissolved solids of fluviatile waters. Sverdrup (*3*) gave no value for the $SiO_2$ as a dissolved solid in sea water, but in a table showing the elements present in sea water, he gave the value of silicon as 0.02–4 ppm. Clarke (*2*) observed, in regard to the small amount of silica in ocean waters, that "Silica is assumed to be wholly thrown down, the trifling residue held in solution being negligible."

*Utilization and precipitation of silica.* A tremendous quantity of silica is added to the ocean annually. This indicates that the silica is utilized or precipitated when the fluviatile waters enter the ocean since there is such a small amount present in sea water. The main portion of this discussion is concerned with some of the possibilities of utilization and precipitation of silica when it is brought into the marine environment. Some of these possibilities are as follows: (1) The silica may remain in solution or suspension. (2) The silica may be utilized by marine organisms. (3) The silica may combine with another colloid and be precipitated as a silicate with the excess colloidal silica subsequently crystallizing as colloidal size quartz. (4) The silica may be precipitated to form a relatively pure siliceous sediment. These 4 possibilities will be discussed in more detail and each will be analyzed for its relative merits.

If the silica which is carried to the oceans remained in solution or suspension, there would be much more in sea water than is now present. The silica now present in solution in sea water must be in equilibrium with respect to sea water, otherwise the amount would increase continually. Enough silica probably remains in solution to maintain this equilibrium, and the rest must be precipitated or utilized by marine organisms.

Marine organisms, especially diatoms and radiolarians, use silica as the structural constituent of their tests. These animals are planktonic types and live in areas in the open sea where the silica is present in very small amounts, which indicates that there is enough present under normal equilibrium conditions in sea water to sustain the needs of these animals. Rankama and Sahama (*4*) indicate that the difference in the amount of silica in the dissolved solids of fluviatile and sea water is due to its utilization as a structural constituent in shells of certain marine organisms. They state also that "There is no evidence of inorganically precipitated silica in recent marine sediments and, therefore, the inorganic deposition of silica in sea water is geochemically unimportant." The authors believe that a large quantity of the silica present in recent marine sediments is inorganic in origin. This is difficult to prove but, as will be shown later in this discussion, the data on the amount present, the content of sea water, and the habitat of most siliceous organisms are all factors which support the observation that much of the silica is inorganic in origin.

A third possibility is that the silica which is carried to the sea, either in solution or in colloidal suspension, may combine with some other colloid or ion to form a silicate. This would seem to be a reasonable hypothesis since colloidal silica and the $SiO_3$ ion are both negatively charged. A combination with some positive colloid or positive ion could result, and during diagenetic changes produce a silicate. Aluminum hydroxide is a positive colloid and ferric hydroxide can be either positive or negative. It seems plausible that the colloidal silica could combine with aluminum hydroxide or ferric hydroxide to form clay minerals and iron hydroxides. After these negative colloids have been satisfied, the excess colloidal silica could form colloidal-size quartz. Buckley (*5*) gives reference to the fact that the relationships of size and solubility may produce a very small particle which does not tend to grow larger. If the dispersion of the colloid is great and the solubility very small, this situation described

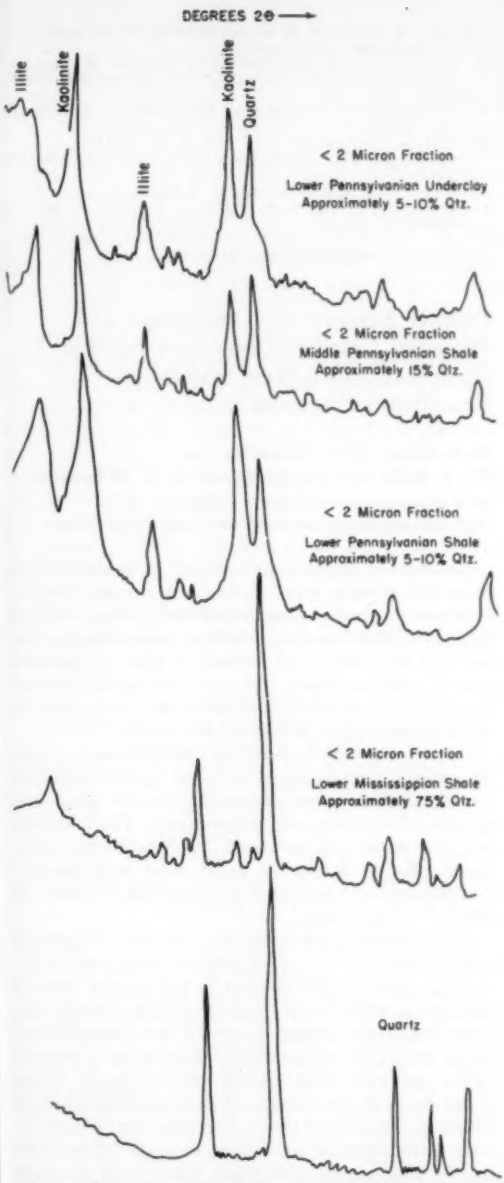


FIG. 1. Some x-ray spectrometer traces of clays and shales showing the approximate quantity of colloidal silica.

by Buckley may be produced and thus explain the presence of colloidal-size quartz in ancient sediments.

*Data on colloidal quartz in sediments.* Revelle (*6*) found, in his studies of some bottom samples of the Pacific, that x-ray powder photos of the colloidal fractions of all samples yielded diffraction lines identical to those of the mineral quartz.

Correns (*7*) in his work on the sediments of the Equatorial Atlantic Ocean, analyzed the fine fractions by x-ray methods. His analyses of the $<1\ \mu$ fraction show quartz present in the great majority of the samples and in the majority of cases in amounts from 10–50%. This would seem to substantiate the hypothesis that there is a large quantity of silica in the form of the mineral quartz in the colloidal range.

In the study of some recent sediments of the Pacific Ocean, Grim, Dietz, and Bradley (*8*) found that quartz was present in the $<1\ \mu$ fraction of almost every sample. They estimated that there was 5–10% quartz in the 1–0.1 $\mu$ fraction and from 1–2% in the $<0.1\ \mu$ fraction.

There have been very few mineralogical analyses of the fine fractions of recent marine sediments, but the data which are available in the literature show that there is a substantial quantity of colloidal quartz.

In ancient clays and shales, quartz is present in the $<2\ \mu$ fraction of almost every clay or shale of Paleozoic age that the authors have analyzed (Fig. 1). This indicates that colloidal quartz may be an important constituent in ancient clays and shales.

Johnson (*9*), in a study of the insoluble residues of some limestones of Indiana, found that quartz was present in all the fine-size fractions and that it usually was the main constituent. This may mean that in a chemical sediment such as a limestone, colloidal silica may be precipitated and later crystallize to colloidal-size quartz.

The average chemical analysis of shale (*2*) reveals that there is 58.10% $SiO_2$. Mason (*10*) states that argillaceous rocks with more than 50% $SiO_2$ generally contain free silica. Although some of the quartz is present as detrital grains in the silt fraction, much of the quartz in the clay fraction is the result of colloidal silica deposition and from this a crystal formation to colloidal-size quartz.

The average chemical composition of 235 samples of Mississippi delta sediments (*11*) reveals that there is 69.96% $SiO_2$ and 10.52% $Al_2O_3$. The delta sediments are higher in silica than the average shale, as would be suspected since the silica probably is precipitated along with some clay minerals on the delta as soon as it comes into contact with sea water. There is the problem of spreading the precipitated silica to other areas of the ocean floor by currents, and density or turbidity currents could carry the silica to the pelagic and abyssal zones of the ocean bottom.

The data in the preceding paragraphs indicate that a considerable quantity of colloidal-size quartz is present in both recent and ancient sediments. It seems reasonable that most of this colloidal-size quartz is deposited by inorganic chemical precipitation from solution or by flocculation of colloidal silica when it comes in contact with ions or electrolytes in sea water.

*Deposition of siliceous formations.* The writers will not attempt to review the literature pertaining to the origin of cherts. An excellent summary of the more important hypotheses for the origin of chert is given by Pettijohn (*12*).

From the preceding data, it seems probable that large amounts of silica are being and have been deposited in marine sediments, especially shales. If conditions are suitable, there could be a segregation of silica, either during weathering or during transport and deposition, whereby relatively pure siliceous deposits could be precipitated.

Much of the segregation could take place upon weathering. From a study on the weathering of a granite gneiss, Goldich (*13*) has indicated that the residual products contain much more alumina and less silica than the original rock. Mason (*10*) states, "From pH 5–9 the solubility of silica increases considerably, but alumina is practically insoluble. Under these conditions, removal of silica can take place, leaving alumina behind, as has been inferred during the formation of laterites and bauxites."

The pH of 5–9 is a common pH of present-day streams and silica would, therefore, be predominant over alumina. This is borne out from the data by Clarke on analyses of river water which were given before in this discussion.

In order to obtain a clean separation of silica, the land in all probability must be in a state of low relief. Under conditions of low relief it would be possible to have a mantle of residual material which would retain the alumina and iron and contribute relatively large quantities of silica to fluviatile waters. It is believed that relief is a very important factor in the formation of siliceous deposits. This is not a new idea. Moore and Maynard (*14*) stated, "At the present time the greater portion of the silica entering sea water is being deposited with the clays and silts, but at times of peneplanation, when chemical denudation is at its maximum, the silica as well as other chemical precipitates might form pure deposits."

When the silica, which is weathered under the conditions outlined above, is carried to the sea, it is in all probability precipitated or flocculated. The mechanism must be that the silica is precipitated by the presence of large amounts of electrolytes or ions in sea water. If $Fe^{+++}$, $Al^{+++}$, or some other highly charged cation or positive colloid were present, it is possible that it would be attracted to the $SiO_3$ ion or to the negatively charged colloidal silica and cause precipitation or flocculation to form clay minerals. A small amount of a highly charged cation could precipitate a large quantity of silica. During diagenesis the excess silica could be released from the complex to form colloidal-size quartz.

### References


1. Roy, C. K. *Am. J. Sci.*, **243**, 393 (1945).
2. Clarke, F. W. *U. S. Geol. Survey Bull.* 770 (1924).
3. Sverdrup, H. V., Johnson, M. W., and Fleming, R. H. *The Oceans.* New York: Prentice Hall (1942).
4. Rankama, K., and Sahama, Th. G. *Geochemistry.* Chicago: Univ. of Chicago Press (1950).
5. Buckley, H. H. *Crystal Growth.* New York: Wiley (1951).
6. Revelle, R. *J. Sedimentary Pet.*, **5**, 37 (1935).
7. Correns, C. W. "Die Sedimente des äquatorialen atlantischen Ozeans." *Deutsche atlantische Exped. Meteor.*, 1925–27, Wiss. Erg. Bd. III, Teil III.
8. Grim, R. E., Dietz, R. S., and Bradley, W. F. *Bull. Geol. Soc. Amer.*, **60**, 1785 (1949).
9. Johnson, F. W. "Non-Carbonate Minerals in some Indiana Limestones and Dolomites." Unpublished M.S. thesis, Indiana Univ.
10. Mason, B. H. *Principles of Geochemistry.* New York: Wiley (1952).
11. Steiger, G. *J. Wash. Acad. Sci.*, **4**, 59 (1914).
12. Pettijohn, F. J. *Sedimentary Rocks.* New York: Harper (1949).
13. Goldich, S. S. *J. Geol.*, **46**, 17 (1938).
14. Moore, E. S., and Maynard, J. E. *Econ. Geol.*, **24**, 272 (1929).


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## Diethyl 2-chlorovinyl Phosphate and Dimethyl 1-carbomethoxy-1-propen-2-yl Phosphate—Two New Systemic Phosphorus Pesticides


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The use of organic phosphates as pesticides has increased rapidly since their discovery by Gerhard Schrader (*1*) in Germany immediately prior to World War II. Following this, Schrader proceeded to demonstrate the activity of certain of these as systemic poisons: poisons taken into and transported through the plant. Much additional work has been done by other workers since Schrader's discovery.

During an investigation of certain new organic phosphorus compounds at the Shell Agricultural Laboratory, 2 have given outstanding results when used as systemic poisons and as fumigants. The 2 organic phosphorus compounds are diethyl 2-chlorovinyl phosphate (distils at 116° C at 10 mm) and dimethyl 1-carbomethoxy-1-propen-2-yl phosphate (distils at 106–7.5° C at 1 mm).

The systemic activity of the two new compounds was measured by a root absorption technique. In this test the materials are diluted to the desired ppm of toxicant in water from a 1% by weight acetone solution. This dilute solution is placed in a 250-ml Erlenmeyer flask and a pinto bean plant with 2 primary leaves and with roots washed free of soil is placed in the flask. A gas barrier of nonabsorbent cotton is placed in the neck of the flask around the stem of the pinto bean plant to prevent fumigation effects from volatile compounds. The pinto bean plant has been infested previously with 2-spotted mites, *Tetranychus bimaculatus,* Harvey. Mortality counts are made 48 hr after introduction into the flask. Two compounds that have systemic activity and are in commercial use were used as reference materials, i.e., Systox[1] (diethyl 2-mercaptoethyl thionophosphate) and OMPA[2] (octamethylpyrophosphoramide).

[1] Chemagro Corporation, 350 Fifth Avenue, New York 1, N. Y.

[2] Monsanto Chemical Company, St. Louis 4, Mo.

TABLE 1

CONTACT SPRAY AND SYSTEMIC ROOT ABSORPTION ACTIVITY OF ORGANIC PHOSPHORUS COMPOUNDS

| Compound | Contact Approx. $LD_{50}$ g/100 ml | | | Systemic $LD_{50}$ ppm* | Mammalian, acute oral $LD_{50}$ mg/kilo | |
|---|---|---|---|---|---|---|
| | Pea aphid | 2-Spotted mite | Housefly | | Mice | Rats |
| Diethyl 2-chlorovinyl phosphate | 0.09 | 0.05 | 0.02 | 0.75 | 30.5 | 7.0 |
| Dimethyl 1-carbomethoxy-1-propen-2-yl phosphate | 0.002 | 0.008 | 0.008 | 0.75 | 9.0 | 4.0 |
| Systox | 0.001 | 0.006 | 0.1 | 1.5 | — | 8.0 |
| OMPA | 0.07 | 0.1 | > 5.0 | 25.0 | — | 13.5 |

* Parts toxicant per million parts water.

Laboratory contact spray tests with these compounds have been run using pea aphids, *Macrosiphum pisi* (Kalt.), and adult houseflies, *Musca domestica* L., in addition to 2-spotted mites. The mammalian toxicity for diethyl 2-chlorovinyl phosphate and dimethyl 1-carbomethoxy-1-propen-2-yl phosphate was determined by Kodama, Morse, and Hine (*2*). A figure for OMPA was taken from Lehman (*3*) and that for Systox was supplied by the manufacturer.

Contact, systemic, and mammalian toxicity data are given in Table 1. It may be seen that the new compounds showed extremely high systemic activity, moderate to high contact activity, and mammalian toxicities approximately equal to those of Systox and OMPA.

TABLE 2

FUMIGATION ACTIVITY TO RED FLOUR BEETLE, *Tribolium castaneum*, AT 25.5° C

| Compounds | Space fumigation | | Grain fumigation | |
|---|---|---|---|---|
| | Dose | Results | Dose | Results |
| | ml/500-ml flask | % mortality, 24 hr | ml/2-qt jar | % mortality, 24 hr |
| Diethyl 2-chlorovinyl phosphate | 0.0001 | 100 | 0.0012 | 88 |
| | | | 0.005 | 100 |
| Dimethyl 1-carbomethoxy-1-propen-2-yl phosphate | 0.0004 | 35 | 0.0012 | 52 |
| | 0.0015 | 90 | 0.005 | 100 |
| Chloropierin | — | — | 0.004 | 0 |
| | — | — | 0.015 | 100 |
| Methyl bromide | — | — | 0.004 | 2 |
| | — | — | 0.015 | 100 |

The space fumigation effects of these compounds were determined in 500-ml glass flasks against the red flour beetle, *Tribolium castaneum* (Herbst). To determine the effects in grain, the same species was used in 2-qt jars filled with barley. Results are summarized in Table 2. These data indicate high activity of the compounds as space fumigants and a greater activity for the compounds as grain fumigants than is obtained with either chloropierin or methyl bromide.


**References**

1. SCHRADER, G. *The Development of New Insecticides*. B.I.O.S. Final Report No. 714 (revised), London: H.M.S.O. (1947).
2. KODAMA, J., MORSE, M., and HINE, C. H. *Federation Proc.*, in press.
3. LEHMAN, A. J. *Assoc. Food & Drug Officials U. S., Quart. Bull.*, **15**, 122 (1951).



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## The Hydrogen Ion Concentration of Human Fetal Blood in Utero at Term


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Recent studies of the acid-base and electrolyte status of newly born infants have reinforced the impression that these infants maintain equilibria substantially different from those of the adult (*1*). The outstanding differences are a lower pH in the blood and a lower $CO_2$ content in the plasma.

The investigations of Noguchi (*2*) concerning the pH of the infant's blood at birth make it clear that acidosis is present at that time. They do not, however, demonstrate whether this acidosis is a consequence of labor or maintenance of in utero conditions. pH data are at present available on only 5 infants in utero (*3, 4*). The values on 4 of these (*4*) vary widely, include contradictory differences and are based on calculation rather than direct mensuration. It, therefore, appeared desirable to measure the pH of the blood of the human fetus in utero at term.

Blood samples were obtained at the time of elective Cesarean section at term. The mothers received a variety of preanesthetic medications, followed by local infiltration anesthesia. Maternal blood samples were procured from a peripheral and from a uterine vein. The uterine incision was made and the umbilical cord only delivered. Fetal blood samples were then taken simultaneously from umbilical artery and vein. Oiled, heparinized syringes were employed, and after filling were capped and placed in ice.

pH determinations were made by means of a glass electrode as soon as possible after sampling. Samples

[1] pH determinations were done through the cooperation of E. B. Brown of the Department of Physiology and J. D. MacCarthy of the Department of Laboratory Medicine.

TABLE 1

pH of Blood Samples

| | Maternal peripheral vein | Maternal uterine vein | Umbilical vein | Umbilical artery |
|---|---|---|---|---|
| 1† | 7.36 | 7.36 | 7.31 | 7.22 |
| 2 | * | 7.34 | 7.34 | 7.29 |
| 3 | 7.38 | 7.38 | 7.32 | 7.24 |
| 4 | 7.37 | 7.34 | 7.31 | 7.24 |
| 5 | 7.39 | 7.36 | 7.31 | 7.27 |
| 6 | 7.34 | 7.32 | 7.31 | 7.22 |
| 7 | 7.40 | 7.34 | 7.32 | 7.25 |
| 8 | 7.39 | 7.39 | 7.35 | 7.28 |
| 9 | 7.42 | 7.42 | 7.31 | 7.27 |
| 10 | * | * | 7.30 | 7.25 |
| 11 | 7.37 | * | 7.32 | 7.29 |
| 12 | 7.37 | 7.35 | 7.34 | 7.30 |
| Mean | 7.38 | 7.36 | 7.32 | 7.26 |

* Unsatisfactory sample.

† In the first mother and fetus studied, the values obtained were respectively 7.36, 7.32, 7.01, and 6.98. The order of magnitude and range of subsequent observations indicate that these fetal values belong to a different universe of data. Intrauterine fetal embarrassment, in the presence of which Eastman noted similarly low fetal pH values, was not present. There is neither clinical nor technical explanation at present for the extreme deviation of this one set of data, and therefore, it is not included in the table.

were identified to the person doing the determination by number only. Two different electrodes were employed, one in a water bath, and the other in an incubator, each with a different galvanometer system. There was no difference in the mean or range of the 2 sets of values. Each system was sensitive to less than 0.005 pH unit.

The results are presented in Table 1. The mean pH of umbilical vein blood is 7.32, and that of umbilical artery blood, 7.26. These values are almost identical with those of Noguchi, obtained on infants at birth. It is, therefore, certain that the human infant in utero at term exists in a state of acidosis relative to its mother. This may not be altered by normal labor. Since the umbilical artery in utero carries a mixed arterial-venous blood, it is likely that the acidosis in fetal tissues at term is of a degree hitherto unsuspected and sufficient to affect gas exchange and alter metabolic processes significantly.

**References**


1. Graham, B. D., *et al. Pediatrics*, **8**, 68 (1951).
2. Noguchi, M. *Japan. J. Obstet. Gynecol.*, **20**, 248 (1937).
3. Eastman, N. J. *Bull. Johns Hopkins Hosp.*, **50**, 39 (1932).
4. Haselhorst, G., and Stromberger, K. *Z. Geburtshülfe u. Gynäkol.*, **102**, 16 (1930).


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# *Comments and Communications*

## Scientific Conferences and Papers

A communication by Paul F. Klens in Science (**117**, 112 [1953]) had some excellent advice on the preparation of papers for scientific meetings and their delivery. I add some comments and suggestions. Lantern slides should not have any details that cannot be read easily with the unaided eye, when held in the hand before a light. There should not be more than 26 lines of typed material single spaced, and a line should not have more than 65 letters or figures.

There is a curious expression of self-consciousness in the deplorable tendency to take rear seats and leave front seats vacant, thus adding to the difficulty of hearing a weak-voiced speaker and of seeing details in badly planned slides.

Local committees on arrangements often fail to consider the acoustic properties of rooms used for meetings. Voice amplifiers should be used in large rooms, if obtainable. It has been my observation that failure to provide them is often not because they are not available, but is simply due to thoughtlessness or negligence. When a microphone is provided, it should be used. It is silly vanity to scorn such devices, as often happens. A thoughtful speaker realizes that an audience will probably have one or more members whose hearing is not keen. Furthermore, a speaker is apt to overestimate the volume of his voice. His voice may not be so loud as he thinks or his articulation may not be good. In rooms seating one hundred or more persons, an amplifier is helpful, especially if there are street noises that enter the room, or if there is noisy apparatus in adjacent rooms.

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## Adrenal Weight—Body Weight

In connection with the third and fourth sentences of the paper "The Relation of Adrenal Weight to Body Weight in Mammals" by John C. Christian (Science, **117**, 78 [1953]), I call your attention to our several publications on these relationships. My paper "A Comparison of Certain Gland, Organ and Body Weights in Some African Ungulates and the African Elephant" (*Growth*, **2**, 335–346 [1938]), expressed these relations graphically on a log-log grid. It was shown that the equation $Y = bX^k$ is applicable.

A second paper, "The Scale of Being and the Power Formula" (*Growth*, **5**, 301–327 [1941]), gave the $b$ values for the adrenal gland resulting from the application of the above equation. That paper included adrenal data from the following: 167 reptiles; 220 birds; 1212 domestic, even-toed ungulates; 79 odd-toed ungulates; 86 carnivores; and 251 primates, mostly wild and exclusive of man.

In a third paper, "Brain, Heart, Thyroid, Adrenals and Habitat" (*Growth*, **10**, 15–23 [1946]), the power equation was applied to adrenal-body weight relations of 310 animals including tropical and subarctic rodents, carnivores, ungulates; white whales and porpoise.

In a fourth paper, "Studies in the Comparative Anatomy of the Endocrine System," the following log-log graphs of adrenal-body weights were included: Figure 1, Adrenal and thyroid—body weight relations for 112 reptiles; Figure 2, Adrenal and thyroid—body weight relations for 2709 birds; Figure 3, Adrenal and thyroid—body weight relations for 256 rodents; Figure 4, Adrenal and thyroid—body weight relations for 158 primates.

In addition to the above, G. W. Crile and D. P. Quiring published in the *Ohio Journal of Science* (**40**, 219–259 [1940]), "A Record of the Body Weight and Certain Organ and Gland Weights of 3,690 Animals."

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## Treatment of *Cryptococcus neoformans* in Mice with Stilbamidine[1]

The observation of Elson (*1*) that certain pathogenic fungi were inhibited by low concentrations of propamidine has centered interest in the treatment of fungus diseases with the diamidines. This interest has been kindled by the discovery of the efficacy of stilbamidine (4,4′-stilbenedicarboxyamidine) in the treatment of blastomycosis (*2*, *3*) and actinomycosis (*4*) and of propamidine (*p,p′*-(trimethylenedioxy) dibenzamidine) as an adjunct to ethyl vanillate (ethyl 4-hydroxy 3-methoxy benzoate) in the treatment of histoplasmosis (*5*). Infections due to *Cryptococcus neoformans* have remained resistant to treatment. The favorable response obtained in the treatment of other fungus diseases prompted use of stilbamidine in experimentally induced infections with *Cryptococcus neoformans* of the central nervous system in mice.

Mice were infected with *Cryptococcus neoformans* according to the method of Smith, Mosberg, Maganieillo, and Alvarez de Choudens (*3*). A 48-hr broth culture of *Cryptococcus neoformans* was centrifuged and then resuspended in 1 cc of physiologic saline. After the mouse was anesthetized with ether and the head prepared sterilely, the midpoint of a line drawn between the eyes and the external auditory meatus was found. About 0.2 cm to 0.3 cm above this point a 28-gage needle about 0.5 cm in length was inserted in a rotating fashion to pierce the skull and enter the cerebral cortex. About 0.05–0.08 cc of the suspension of *Cryptococcus neoformans* was injected, the latter being the maximal possible amount.

[1] Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are the result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

Four mice so infected died between the 8th and the 15th day. Fourteen mice similarly infected were treated with 100 mg/kg stilbamidine diiesthionate[2] in 5% glucose in distilled water intraperitoneally. All the mice died between the 6th and 16th day after infection.

Stilbamidine, 50–100 mg/kg, administered intraperitoneally, has been reported as the maximum tolerated dose for mice and it is stated that ¼ to ½ of this dose repeated over several days is usually well tolerated (*6*). The mice in this experiment received 100 mg/kg up to a period of 12 days, before death from the infection. This large dosage did not affect the course of the disease.

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### References

1. Elson, W. O. *J. Infectious Diseases*, **76**, 193 (1945).
2. Schoenbach, E. B., Miller, J. M., and Long, P. H. *J. Am. Med. Assoc.*, **146**, 1317 (1951).
3. Smith, G. W., *et al. Bull. School Med. Univ. Maryland* (in press).
4. Miller, J. M., Long, P. H., and Schoenbach, E. B. *J. Am. Med. Assoc.*, **150**, 35 (1952).
5. Ellis, F. F., Jr., Scott, R. J., and Miller, J. M. *Antibiotics & Chemotherapy*, **2**, 347 (1952).
6. Schoenbach, E. B., and Greenspan, E. M. *Medicine*, **27**, 327 (1948).

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[2] The stilbamidine diiesthionate was supplied by Merck and Company, Incorporated.

## A Combined Method for the Rapid Fixation and Adhesion of Ciliates and Flagellates

In the preparation of protozoan slides, difficulty is often encountered in affixing the animals to the slide without distortion. The method described below eliminates the need of egg albumin and also the drying process. The whole technique takes only 15 seconds, and the animals are simultaneously fixed and attached to the slide. The method makes use of the fact that dispersal currents cause protozoa to adhere to the surface of a glass slide. Among the reagents that produce this effect are: Formalin, ethylene glycol, acetone, ether, chloroform, and the lower alcohols (methyl, ethyl, propyl, butyl, amyl) and some of their isomers. Though all these compounds cause adhesion to the slide, tertiary butyl alcohol yields best results. Ethyl and methyl alcohols may be substituted for tertiary butyl alcohol, but they seem to cause more nuclear distortion.

A mixture of the reagents given below will affix almost all the animals in a droplet of culture. No cellular distortion occurs and cilia, cirri, cytoplasmic

granules, nuclei, and neuromotor apparatus are well preserved.

*Fixative*

10 vols. saturated solution of mercuric chloride
2 vols. glacial acetic acid
2 vols. commercial Formalin
5 vols. tertiary butyl alcohol C.P.

The above reagents are mixed just before using.

1. Place a large drop of culture on a slide (the droplet must be free of debris).
2. Pick up a pipet full of fixative and hold the tip about 2 cm above the slide.
3. Slowly drop the fixative directly onto the droplet of culture.
4. Once the currents have started, lower the tip of the pipet until it is in contact with the slide. Continue to expel the fixative slowly until the slide is flooded.
5. After 15 seconds drain the slide and place in 70% iodine alcohol (3–4 min).
6. Wash in 70% alcohol (3–5 min).

The slide may now be stained by any of the standard methods.

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## "The Coryphaeus of Science"

THE following item is a translation of Lysenko's eulogy (*Pravda*, page 4, March 8, 1953) of the deceased Stalin which I believe will interest the readers of SCIENCE for a variety of reasons.

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Hard, hard beyond words! He has departed from us—he who bestowed upon hundreds of millions of peoples a happy life—our leader, teacher, friend of the workers, great coryphaeus of native science: Iosif Vissarionovich Stalin.

All branches of the sciences—social and natural—drew inspiration and will continue to draw inspiration from the teachings, from the works of Comrade Stalin.

For the development of a materialist biology, for the development of Michurinist theory we are beholden to Iosif Vissarionovich Stalin not only as the greatest builder and director of a socialist government in which have been created as never before favorable conditions for the growth and development of all branches of knowledge, but also as the direct teacher who revealed to us the significance of the works of I. V. Michurin.

Comrade Stalin pointed out the paths for development of the theory of Michurinist materialist biology.

That Comrade Stalin found time even for detailed examination of the most important problems of biology is especially well known to me as a biologist. He directly edited the plan of my paper, "On the Situation in Biological Science"; in detail explained to me his corrections; provided me with directions as to how to write certain passages in the paper. Comrade Stalin paid close attention to the results of the work of the August [1948] session of the Lenin All-Union Academy of Agricultural Sciences [in which "progressive, materialist, Michurinist biology triumphed over reactionary Mendelism-Morganism"].

Lenin discovered Michurin; Stalin nurtured our cadres of Michurinites; Stalin disclosed a series of most important biological principles.

Kolkhozes and sovkhozes, the socialist rural economy, and Michurinist biology have developed and are continuing to develop in indissoluble unity. This the Lenin-Stalinist Party teaches us. This is the sole path for the development of a genuine science, capable of revealing the principles of development of animate nature. Immortal are the cause and works of Lenin and Stalin. They consecrated their whole lives to the people—the builders of communism.

Let us rally yet more closely around the Stalinist Central Committee of the Communist Party and the Soviet government. Let us devote all our strength and knowledge to the cause of Lenin-Stalin, to the cause of building up communism!

Academician T. Lysenko

## Twenty-Fifth Anniversary of the Discovery of the Raman Effect

A MEETING of the members of the Indian Association for the Cultivation of Science was held on March 7, 1953, in the premises of the Association at Jadavpur to celebrate the 25th anniversary of the discovery of the Raman Effect. M. N. Saha, F.R.S., was in the chair. The sequence of events leading to the discovery of the Raman Effect on February 28, 1928, was first narrated briefly by S. C. Sirkar, with the help of slides and demonstrations. Prof. Saha then pointed out that the discovery was one of the most important discoveries in science of this century, and that not only the Association but also the whole country took pride in the fact that such a discovery was made in the laboratories of the Association. He also pointed out that it was only because the Association had been publishing regularly a journal of its own that the discovery could be announced to the scientific world very quickly, so that priority for the discovery could be claimed by Prof. Raman, although a similar phenomenon was observed in the case of quartz a few weeks later by the Russian physicists, Landsberg and Mandelstam. The following resolutions were then adopted unanimously:

"Resolved that the members and staff of the Association express their sincerest felicitations to Prof. C. V. Raman on the 25th anniversary of the discovery of Raman Effect.

"Resolved further that a copy of the resolution be sent to Prof. C. V. Raman."

S. N. SEN

*Indian Association for the Cultivation of Science*

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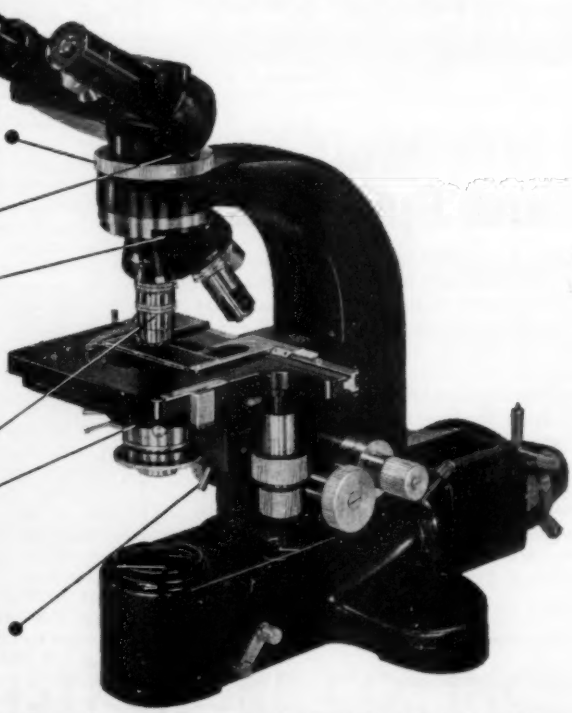

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July 7–9. Research Conference on Female Reproduction in Farm Animals. Iowa State College, Ames, Ia.

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July 13. International Astronomical Union, Symposium on Hydrodynamics of Gaseous Masses. Cambridge, England.

July 13–17. British Medical Association (Annual). Cardiff, Wales.

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July 20–25. International Congress on Medical Librarianship. London.

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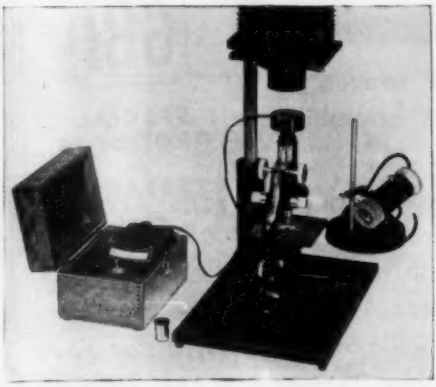

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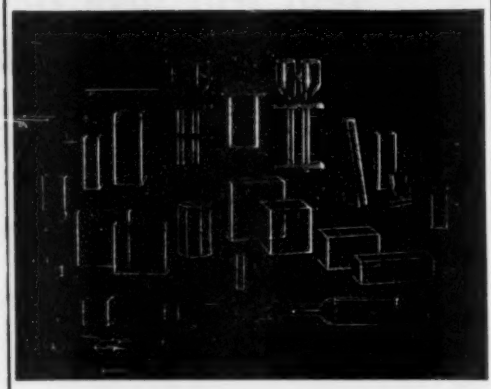

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